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FIG 1. *Digitoramispora tambdisurlensis* sp. nov.
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New cercosporoid fungi from the Brazilian Cerrado 2. Species on hosts of the subfamilies *Caesalpinioideae*, *Faboideae* and *Mimosoideae* (*Leguminosae* s. lat.)

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Abstract — The genus *Passalora* is divided into the morphological sections *Passalora*, *Phaeoramularia*, *Mycovellosiella and Pseudophaeoisariopsis*. New cercosporoid hyphomycetes are described from the Brazilian Cerrado on native plants of the subfamilies *Mimosaoideae* (*Cercospora mimosae-sensitivae*), *Faboideae* (*Passalora* sect. *Mycovellosiella*: *P. acosmii*), and *Caesalpinioideae* (*Passalora* sect. *Mycovellosiella*: *P. chamaecristae-orbiculatae*; *Passalora* sect. *Passalora*: *P. chamaecristicola, P. machaerii*; *Pseudocercospora*: *P. exilis, P. chamaecristigena,* and *P. luzianiensis*). Furthermore, the new combinations *Passalora caesalpiniae* (≡ *Phaeoramularia caesalpiniae*), *P. dalbergiae* (≡ *Mycovellosiella dalbergiae*), *Pseudocercospora bonducellae* (≡ *Helminthosporium bonducellae*) and the new name *Pseudocercospora caesalpiniicola* (≡ *Phaeoisariopsis caesalpiniae*, non *Pseudocercospora caesalpiniae*) are introduced.

Key words — fungal taxonomy, mycodiversity, *Mycosphaerellaceae*, tropical hyphomycetes

Introduction

The traditional *Leguminosae* (including sufamilies *Caesalpinioideae*, *Faboideae*, and *Mimossoideae*) is one of the largest families of flowering plants with ca 18,000 species grouped in about 650 genera, just under a twelfth of all known flowering plants. They are cosmopolitan but especially common in tropical and subtropical areas. They are annual or perennial plants with habits varying from creeping herbs to high trees; some are leafless xerophytes (Polhill & Raven 1981).

The three families of the *Leguminosae* s. lat. are also the largest group of flowering plants in the Cerrado, represented by 101 genera, 777 species and 143 varieties

[1]Portion of the Doctor´s Thesis of the senior author

and subspecies, respectively (Mendonça et al. 1998). Among the most common genera in the Cerrado are *Acosmium*, *Bowdichia*, *Calliandra*, *Dimorphandra*, *Chamaecrista*, *Galactia*, *Machaerium*, *Dalbergia*, *Mimosa*, *Pterodon*, *Senna*, *Sclerolobium* and *Stryphnodendron*.

A continued survey of Cerrado fungi on legumes revealed several new species of the genera *Cercospora* Fresen., *Passalora* Fr. and *Pseudocercospora* Speg. They are described in this contribution which continues the treatment of cercosporoid hyphomycetes of the Cerrado by Hernández-Gutiérrez & Dianese (2008).

As in the previous paper of this series, the taxonomy follows the generic concepts introduced by Deighton (1967, 1974, 1976) and updated by Braun (1999) as well as Crous & Braun (2003), showing the delimitation between *Passalora*, *Phaeoramularia* and *Mycovellosiella* to be vague and not justified, neither on the base of morphological features, since various intermediate taxa exist, nor by using molecular approaches. The broad morphological range of *Passalora* in its current, wide circumscription agrees now with the well-known, traditional concept of *Pseudocercospora*, comprising species with and without external mycelium, with solitary and fasciculate conidiophores, up to sporodochia and synnemata, but all connected by a single, uniform type of conidiogenous locus and conidial hilum. Special taxonomic problems arose around synnematous cercosporoid fungi traditionally assigned to the genus *Phaeoisariopsis* Ferraris. Braun (1990) reallocated cercosporoid *Isariopsis* Fresen. (now *Phacellium* Bonord.) species with pigmented, scolecoid conidia to *Phaeoisariopsis*. As in numerous other hyphomycete genera, it turned out that the formation of synnematous conidiomata is of little taxonomic relevance at generic level in cercosporoid anamorphs. Furthermore, the genus *Phaeoisariopsis* proved to be heterogeneous, comprising passalora-like species with conspicuous, thickened and darkened conidiogenous loci as well as pseudocercospora-like taxa with inconspicuous loci (Deighton 1990, Crous & Braun 2003). Since the type species of *Pseudocercospora*, *P. vitis* (Lév.) Speg., also shows synnematous conidiomata (Deighton 1976), it is artificial and not justified to place other synnematous taxa with unthickened, non-pigmented conidiogenous loci in a separate genus. Based on a molecular and morphological reassessment of *Phaeoisariopsis griseola* (Sacc.) Ferraris, the type species, Crous et al. (2006) reduced the genus *Phaeoisariopsis* to synonymy with *Pseudocercospora*.

Phaeoisariopsis griseola is characterized by having conidiogenous loci ranging from being quite inconspicuous to subconspicuous by being unthickened, but slightly darkened-refractive, at least with regard to the ultimate rim. Since *P. griseola* molecularly clustered within a subclade formed by other *Pseudocercospora* species, it became clear that synnematous taxa with minutely thickened and slightly darkened conidiogenous loci have to be placed in

Pseudocercospora. Hence, species of *Phaeoisariopsis* were reallocated to *Passalora* and *Pseudocercospora*, respectively, depending on the structure of the conidiogenous loci. With regard to former *Phaeoisariopsis* species on legumes, *P. atropunctata*, *P. pulchella* and *P. robiniae* (Shear) Deighton belong now in *Passalora*, whereas *P. bonducellae*, *P. caesalpiniae* and *P. griseola* are now members of *Pseudocercospora* (Crous & Braun 2003). However, most of the species on legumes previously referred to as *Phaeoisariopsis* have already been excluded by previous authors, since they are characterized by having densely fasciculate, but non-synnematous conidiophores, e.g. *Pseudocercospora angustata* (Chupp & Solheim) Deighton (≡ *Phaeoisariopsis angustata* (Chupp & Solheim) L.G. Br. & Morgan-Jones), *Passalora personata* (Berk. & M.A. Curtis) S.A. Khan & M. Kamal (≡ *Phaeoisariopsis personata* (Berk. & M.A. Curtis) Arx).

However, Braun (1995, 1998) introduced formal, non-phylogenetic divisions of *Cercosporella* Sacc., *Pseudocercosporella* Deighton, and *Ramularia* Unger into sections based on morphology, which are useful for taxonomic as well as determination purposes. A similar concept is here applied to *Passalora*, as follows:

Passalora* sect. *Passalora

Superficial mycelium absent; conidiophores fasciculate; conidia solitary, subglobose, ellipsoid-ovoid, fusiform to obclavate-cylindrical, subhyaline to usually pigmented, 0–4- to sometimes pluriseptate.

Passalora* sect. *Phaeoramularia (Munt.-Cvetk.) A. Hern.-Gut. & Dianese, **comb. et stat. nov.**

MycoBank, MB 512204

Bas.: *Phaeoramularia* Munt.-Cvetk., Lilloa 30: 182, 1960.

Superficial mycelium absent; conidiophores fasciculate; conidia catenate, in simple or branched chains, variable in shape, 0–1- to pluriseptate.

Passalora* sect. *Mycovellosiella (Rangel) A. Hern.-Gut. & Dianese, **comb. et stat. nov.**

MycoBank, MB 512205

Bas.: *Mycovellosiella* Rangel, Arch. Jard. Bot. Rio de Janeiro 2: 71, 1917.

Superficial mycelium present, smooth; conidiophores solitary, arising from superficial hyphae or solitary as well as fasciculate; conidia solitary or catenate, variable in shape, continuous to pluriseptate, subhyaline to pigmented.

Passalora* sect. *Pseudophaeoisariopsis U. Braun, Dianese & A. Hern.-Gut., **sect. nov.**

MycoBank, MB 512206

Sine mycelio superficiali, conidiophora longa et dense aggregata, synnemata formantia, conidia solitaria.

Type species: *Passalora atropunctata* (Racib.) U. Braun & F. O. Freire (≡ *Cercosporella atropunctata* Racib.).

Superficial mycelium absent; conidiophores long, densely aggregated, forming genuine synnemata; conidia solitary.

Taxonomy

Cercosporoid fungi on *Mimosoideae*

Cercospora mimosae-sensitivae A. Hern.-Gut. & Dianese, **sp. nov.** Fig. 1

MycoBank, MB 512207

Cercosporae sensitivae *ut videtur similis, sed lesionibus differentibus, conidiophoris longioribus et conidiis distincte longioribus, leviter latioribus et pluriseptatis. Differt a* C. apii *s. lat. (incl.* C. canescens*) conidiis saepe anguste obclavatis, ad basim obconice truncatis.*

Specimens examined: **BRAZIL. Maranhão:** Grajaú, on living leaves of *Mimosa sensitiva*, 5 Apr 1995, *leg. M. Sanchez* 734, **holotype** (UB Mycol. Col. 8303).

Etymology: *mimosae-sensitivae*, derived from the host species.

Lesions 0.5–4 mm diam., amphigenous, circular, brown, greyish in the centre, limited by a dark brown margin and surrounded by a yellowish halo. Colonies amphigenous, caespitose, shiny gray or grayish brown. Stromata absent or poorly developed, textura globosa, superficial, light brown, 13–75 μm diam. Conidiophores loosely fasciculate, simple, straight or slightly curved, cylindrical, 49–131 μm long, 4–7 μm diam. at the widest part, 1–6-septate, light brown, smooth, thin-walled. Conidiogenous cells integrate, terminal or intercalary, polyblastic, sympodial, geniculate, cylindrical, light brown to subhyaline, scars very prominent, thick and dark, 2–3 μm diam. Conidia solitary, curved, flexuous or straight, filiform, narrowly obclavate, sometimes fusoid, truncate to obconical-truncate at the base, obtuse to rounded at the apex, 32–225 μm long, 3–5 μm diam. in the widest part, 2–4 μm at the base, 1–2 μm near the apex, 2–20-septate, hyaline, smooth, thin-walled; hilum prominent, thick and dark, 2–3 μm wide.

Comments: *Cercospora sensitivae* (Speg.) Chupp (⊠ *Cercosporina sensitivae* Speg.) was described from Argentina on *Mimosa sensitiva* (Chupp 1954). Chupp (1954) characterized this species as follows: Leaf spots subcircular or irregular; colonies hypophyllous; stromata dark brown; conidiophores in dense or very dense fascicles, unbranched, curved or flexuous, rarely geniculate, 15–70 μm long (mainly 15–50 μm) and 4–6 μm diam. at the widest part, with small scars; conidia hyaline, cylindrical or almost fusoid, straight or curved, 20–75 μm long and 2–4 μm diam. at the widest part, 3–7 septate. However, the new species on *Mimosa sensitiva* in Brazil differs from Spegazzini´s species in having different leaf spots, longer conidiophores, distinctly longer and

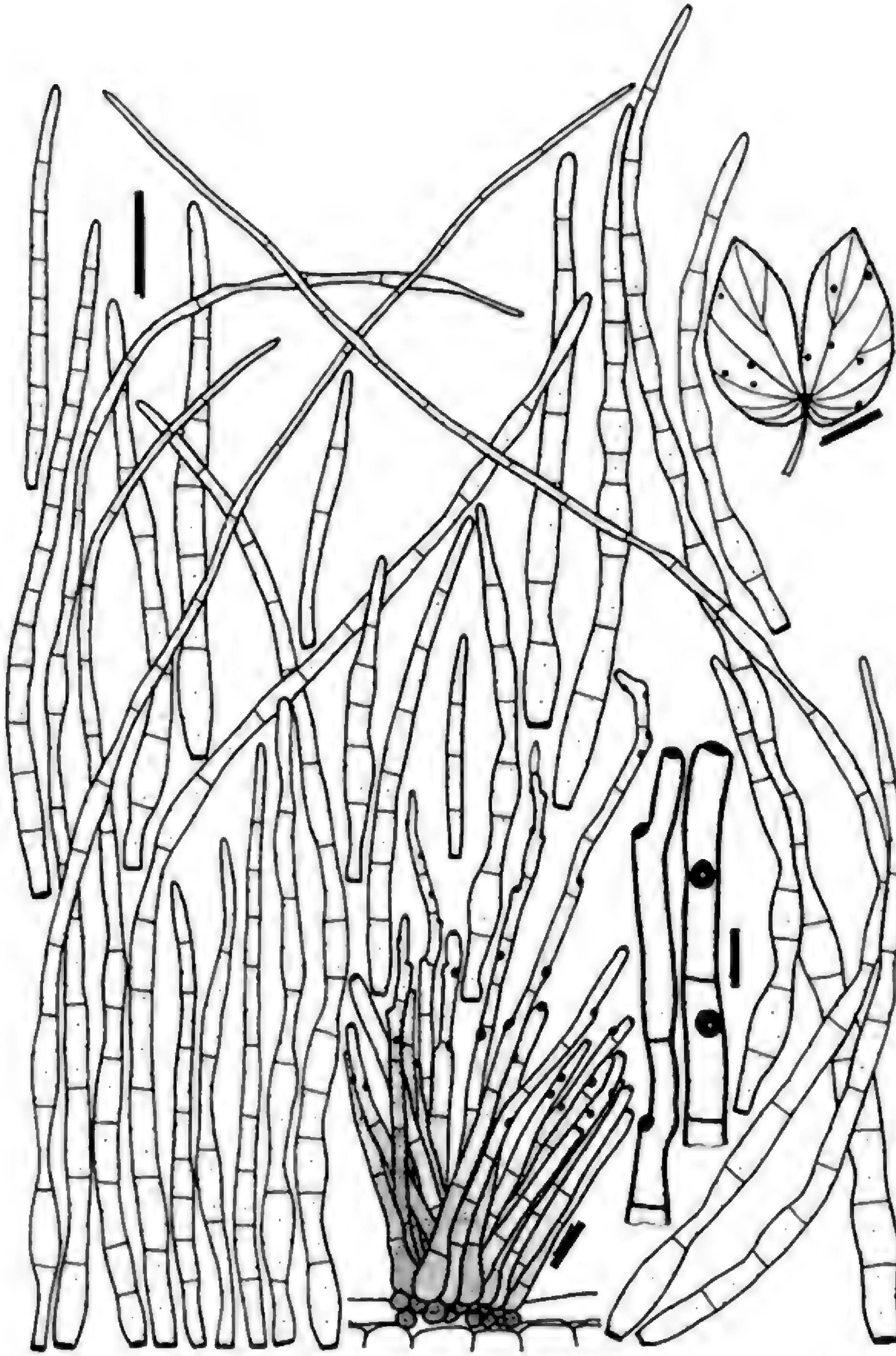

Fig. 1. *Cercospora mimosae-sensitivae* on *Mimosa sensitiva*. Lesions sparsely lesions distributed on two leaflets (top right) (bar = 10 mm); fascicle of conidiophores (bar = 10 µm) with details of the conidiogenous loci to the left (bar = 5 µm) and a surrounding sample of conidia (bar = 10 µm). Based on the holotype (UB Mycol. Col. 8303).

somewhat wider and, above all, pluriseptate conidia. Sutton & Pons (1980: 213) examined type material of *C. sensitivae* and considered it a nomen dubium. Braun (2000) re-examined the type material from LPS and a slide with a preparation of type material deposited at IMI. He found a few conidia agreeing with Chupp´s (1954) description, but the material was too meager to prove the generic affinity of this species, i.e., thickened and darkened-refractive hila, characteristic for *Cercospora* s. str., were not observed. Therefore, it could not be confirmed that this species pertains in the latter genus, i.e. an affinity of *C. sensitivae* to *Pseudocercospora* could not be excluded (U. Braun, in litt.). Beside *C. sensitivae*, only *C. canescens* Ellis & G. Martin (= *C. apii* Fresen. s. lat.) has been recorded on *Mimosa* spp. (Crous & Braun 2003), which is, however, clearly distinct by having acicular conidia with truncate base.

Cercosporoid fungi on *Faboideae*

Passalora sect. *Mycovellosiella*

Passalora acosmii A. Hern.-Gut. & Dianese, **sp. nov.** Fig. 2

MycoBank, MB 512208

Passalorae sweetiae *similis, sed conidiophoris interdum per stomata emergentibus, pluriramosis, brevioribus, leviter angustioribus et conidiis interdum catenulatis.*

Specimen examined: **BRAZIL. Distrito Federal:** Planaltina, Estação Ecológica de Águas *Emendadas*, on living leaves of *Acosmium subelegans* (Mohlenbr.) Yakovlev [≡ *Sweetia subelegans* Mohlenbr.], 31 Aug 1998, *leg P.T.O. Ferreira* 7, **holotype** (UB Mycol. Col. 17204).

Etymology: *acosmii*, derived from the host genus.

Lesions 2–24 mm diam., hypophyllous, irregular, coalescent, yellowish to ochraceous, without a defined margin. Colonies exclusively hypophyllous, effuse, velvet or cottony, yellowish or ochraceus. Stromata absent or very poorly developed textura globosa, small, single-layered, substomatal. Primary conidiophores emerging through stomata, in loose fascicles, strongly branched, forming a complex network, 5–8 μm diam. Secondary conidiophores formed singly on branched creeping hyphae, 46–63 μm long, 5–7 μm diam. at the widest part, 2–4-septate, ochraceous to yellowish brown, thin-walled, smooth. Conidiogenous cells integrate, terminal or intercalary, polyblastic, sympodial, geniculate, with prominent and pigmented scars, 5–8 μm diam. Conidia solitary or rarely in short chains, straight or curved, broadly obclavate, cylindrical or obovoid, catenulate conidia obconically truncate at the base and conical-truncate at the apex, with thick and pigmented hilum, 2–4 μm wide, solitary conidia broadly round at the apex, 15–44 μm long, 5–7 μm diam. at the widest part, 1–3 μm at the base, 2–5 μm near the apex, 0–5-septate, yellow, ochraceous or light yellowish brown, thin-walled, smooth.

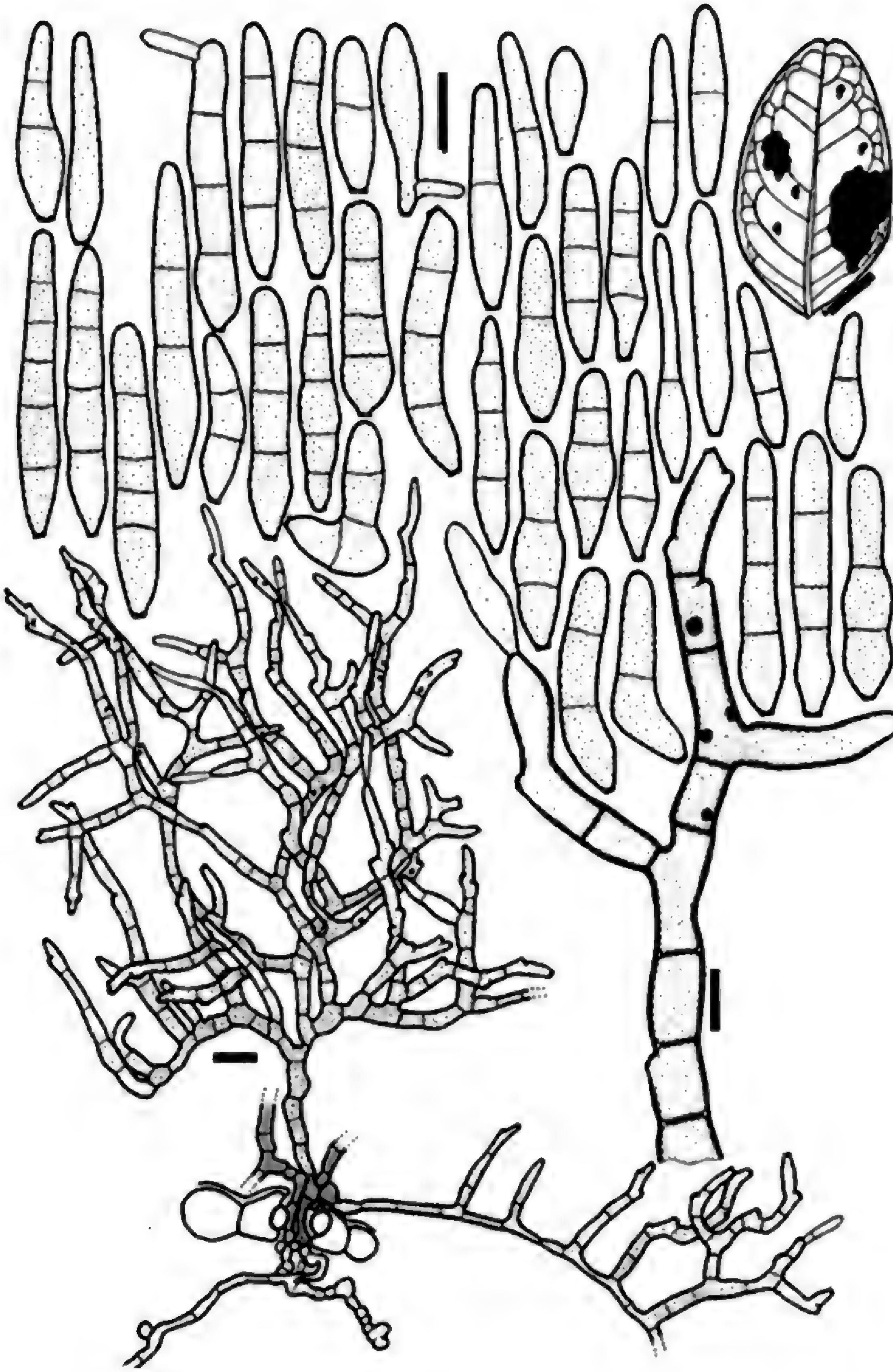

Fig. 2. *Passalora acosmii* on *Acosmium subelegans*. Lesions on a leaflet at top right (bar = 10 mm); branched superficial mycelium (bar = 10 µm) growing from a stoma with details of conidiophore and conidiogenous cells shown on the right side (bar = 5 µm), both topped by a sample of conidia with a variety of shapes (bar = 10 µm). Based on the holotype (UB Mycol. Col. 17204).

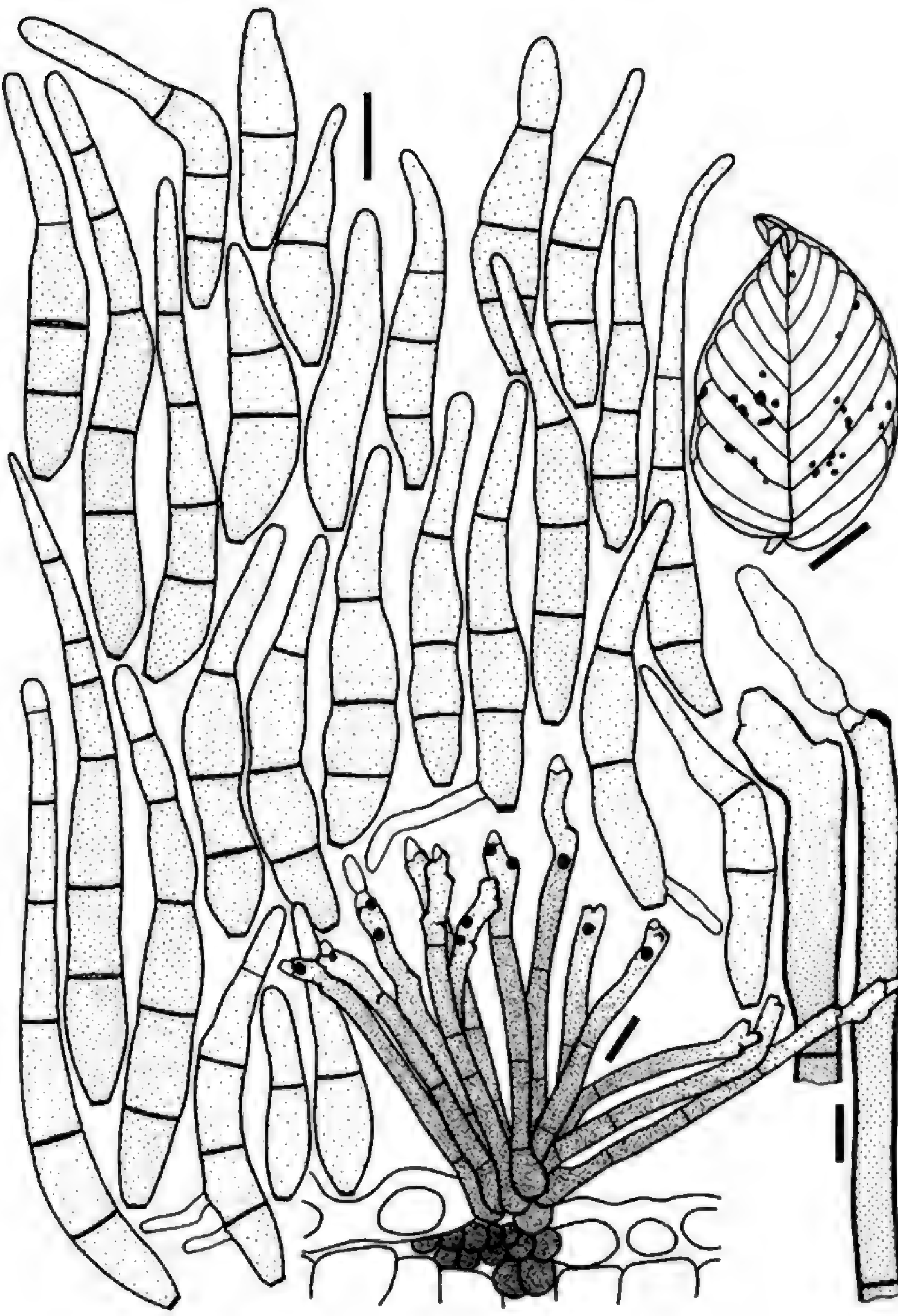

Fig. 3. *Passalora machaerii* on *Machaerium opacum*. Lesions on a leaflet (top right) shown as small scattered spots (bar = 10 mm); a representative sample of conidia (bar = 10 μm) on top of a fascicle of conidiophores (bar = 10 μm) originated from a substomatal stroma. Based on the holotype (UB Mycol. Col. 8667).

Comments: *Acosmium* is a genus of the *Faboideae* [*Leguminosae*, *Sophoreae*], previously considered a section of *Sweetia*. The new species *Passalora acosmii* resembles *P. sweetiae* K. Schub. & U. Braun [≡ *Cladosporium ferrugineum* Allesch., non *Passalora ferruginea* (Fuckel) U. Braun & Crous], known from Brazil, Minas Gerais, on *Sweetia bijuga* (Schubert & Braun 2005). The latter species is characterized by similar conidia, and leaf spots are lacking as in *P. acosmii*, but the conidiophores are consistently solitary, arising from superficial hyphae, unbranched, longer and wider, up to 213 × 10 µm. The Brazilian *Passalora chuppii* (Viégas) U. Braun & Crous (Chupp 1954, Crous & Braun 2003) on *Ormosia*, an allied genus of the *Sophoreae*, is a quite distinct phaeoramularia-like species, i.e., external hyphae with solitary conidiophores are lacking. There are two additional cercosporoid species in Asia on hosts of the *Sophoreae*, but they pertain to other genera, viz. *Cercospora sophorae* T.S. Ramakr. & K. Ramakr. and *Pseudocercospora cladrastidis* (Jacz.) J.K. Bai & M.Y. Cheng (Chupp 1954, Crous & Braun 2003). Among other mycovellosiella-like *Passalora* species on hosts of the *Faboideae* , there are only few species characterized by lacking stromata and branched conidiophores, viz. *Passalora hariotii* (Speg.) U. Braun & Crous (Deighton 1974) and *P. pirozynskii* (Deighton) U. Braun & Crous (Deighton 1987). However, *P. pirozynskii* is distinguished by having moderately branched conidiophores, less profuse than the net-forming conidiophores of *P. ascomii*, and narrower conidia formed singly. *P. hariotii* has also less branched conidiophores and solitary conidia.

Passalora sect. *Passalora*

Passalora machaerii A. Hern.-Gut. & Dianese, **sp. nov.** Fig. 3

MycoBank, MB 512211

Passalorae dalbergiicolae *valde similis, sed stromatibus bene evolutis, 46–73 µm diam., conidiis longioribus, 0–7-septatis.*

Specimens examined: **BRAZIL. Distrito Federal**: Planaltina, Estação Ecológica Águas Emendadas, on living leaves of *Machaerium opacum*, 6 Jun 1995, *leg M. Sanchez* 893, **holotype** (UB Mycol. Col. 8667); **Goiás**: Cristalina, Fazenda Nova Índia, on living leaves of *M. acutifolium*, 10 Apr 1993, *leg R..B. Medeiros* 236, **paratype** (UB Mycol. Col. 3728); **Distrito Federal**: Brasília, Asa Norte, SQN 415, on living leaves of *M. acutifolium*, 2 May 1993, J. C. Dianese 871, **paratype** (UB Mycol. Col. 3857).

Etymology: *machaerii*, derived from the host genus.

Lesions 1–3 mm diam., amphigenous, circular or irregular, dark brown, without a delimiting margin. Colonies amphigenous, gregarious, yellowish brown. Mycelium internal. Stromata 46–73 µm diam., formed by cells of textura globosa, usually superficial or subepidermal, light brown. Conidiophores in loose fascicles, simple, straight or slightly curved, cylindrical, 76–130 µm long, 6–8 µm diam. at the widest part, 2–3-septate, light olivaceous, smooth, thin-

walled. CONIDIOGENOUS CELLS integrate, terminal, polyblastic, sympodial, geniculate, with prominent, thick, pigmented scars, 5–6 µm diam. CONIDIA solitary, cylindrical, obclavate, curved, sometimes fusoid, obconically truncate at the base with a thick, dark hilum; rounded to broadly rounded or obtuse at the apex, 31–96 µm long, 7–10 µm diam. at the widest part, 2–5 µm at the base, 3–5 µm near the apex, 0–7-septate, light olivaceous to subhyaline, smooth, thin-walled.

COMMENT: The genus *Machaerium* belongs in the *Faboideae* [*Leguminosae*, *Dalbergieae*]. Since species of the cercosporoid genera *Passalora* and *Pseudocercospora* are, as far as known, strictly confined to species of a single host genus or at most hosts of closely allied genera, it is necessary to compare the new species at first with allied host genera of the *Dalbergieae*. *Passalora machaerii* is characterized by lacking superficial hyphae, fasciculate conidiophores and conidia formed singly. Most species of *Passalora* known on allied hosts pertain to other morphological groups. *Passalora amazonica* U. Braun on cf. *Lonchocarpus* sp. in Brazil (Braun 2003) and *P. ougeiniae* (M.D. Mehrotra & R.K. Verma) U. Braun & Crous on *Dalbergia oojeinensis* in India (Crous & Braun 2003) are phaeoramularia-like, i.e. the conidia are formed in chains.

Passalora dalbergiae (S.K. Singh & P.N. Singh) U. Braun, Dianese & A. Hern.-Gut., **comb. nov.**

MYCOBANK, MB 512221

Bas.: *Mycovellosiella dalbergiae* S.K. Singh & P.N. Singh, in Singh et al., Indian Phytopathol. 57(2): 155, 2004.

On *Dalbergia sissoo* in India, *P. nervisequens* (J. Kranz) U. Braun & Crous on *Pterocarpus erinaceus* in Guinea (Braun et al. 1999, Crous & Braun 2003) and *P. pumila* (Syd. & P. Syd.) U. Braun & Crous on *Derris* spp. in Asia (Chupp 1954, Crous & Braun 2003) are mycovellosiella-like, i.e. they form superficial hyphae with solitary conidiophores. *Asperisporium pongamiae* (Syd.) Deighton (≡ *Passalora pongamiae* (Syd.) Subram.) on *Pongamia glabra* in Asia (Ellis 1976) is quite distinct by its verrucose conidia.

Passalora dalbergiicola (T.S. Ramakr. & K. Ramakr.) U. Braun & Crous, known from India on *Dalbergia volubilis* (Chupp 1954, Vasudena 1963, Ellis 1976, Crous & Braun 2003), is the only comparable species on an allied host. It is morphologically very close to *P. machaerii*, but differs in having small stromata and shorter, (1–)3(–4)-septate conidia, 25–45 × 7–10 µm.

There are various other morphologically comparable *Passalora* species on leguminous hosts, which are not closely allied to *Machaerium*. *Passalora atropunctata* (Racib.) U. Braun & O.F. Freire (≡ *Phaeoisariopsis atropunctata* (Racib.) U. Braun, = *Phaeoisariopsis caespitosa* (Petr. & Cif.) S.C. Jong & E.F.

Morris) on *Desmodium* spp. and *P. pulchella* (T.S. Ramakr.) U. Braun & Crous (≡ *Phaeoisariopsis pulchella* (T.S. Ramakr.) U. Braun & Bagyan.) are distinguished by the formation of genuine synnemata, much longer conidiophores and shorter, usually 3-septate conidia (Ellis 1976, Braun 1990). *Passalora aenea* (Cif.) U. Braun & Crous (= *Cercospora cassiae* Henn., non *Passalora cassiae* Syd.) on species of *Cassia*, *Chamaecrista* and *Senna*, *P. caracasana* Syd. on *Parosela barbata*, *P. desmanthi* (Ellis & Kellerm.) U. Braun on *Desmanthus* spp., *P. gliricidiasis* (Gonz. Frag. & Cif.) U. Braun & R.F. Castañeda on *Gliricidia* spp. and *P. personata* on *Arachis* spp. are characterized by having large, dense fascicles of conidiophores and shorter conidia with 0–4 septa (Chupp 1954, Deighton 1967, Ellis 1976, Crous & Braun 2003). *Passalora tephrosiae* S.A. Khan & M. Kamal on *Tephrosia* spp. in Asia and North Africa possesses verruculose conidia, i.e. this species is rather asperisporium-like.

Cercosporoid fungi on *Caesalpinioideae*

Passalora sect. *Mycovellosiella*

Passalora chamaecristae-orbiculatae A. Hern.-Gut. & Dianese, **sp. nov.** Fig. 4
MycoBank, MB 512209

Passalorae grecianae *similis, sed laesionibus distinctis, conidiophoris solitariis et fasciculatis, angustioribus, 3–5 µm latis, conidiis angustioribus, 2–3 µm latis, interdum catenulatis.*

Specimen examined: **BRAZIL. Goiás:** Catalão, BR-050 Highway, Km 264, between Catalão and Davinópolis, on living leaves of *Chamaecrista orbiculata*, 6 Nov 1993, *leg M. Sanchez* 135, **holotype** (UB Mycol. Col. 5550).

Etymology: *chamaecristae-orbiculatae*, derived from the host species.

Lesions 2–40 mm diam., amphigenous, irregular, coalescent, occupying large areas limited by the main veins, violaceous-brown, limited by a dark brown margin. Colonies amphigenous, olivaceous, effuse. Stromata substomatal, 26–45 µm diam., textura globosa, sometimes forming rudimentary superficial stromata. Primary conidiophores in loose fascicles, emerging directly from substomatal or superficial stromata, simple or branched, straight or curved, with monopodial rejuvenations giving rise to annellate structures, 25–40 µm long, 3–5 µm diam. at the widest part, 2–6-septate, branched, thin-walled light olivaceous to light brownish olivaceous, smooth. Secondary conidiophores solitary, formed laterally on superficial, smooth hyphae. Conidiogenous cells integrated, terminal, polyblastic, sympodial; scars not very prominent, but slightly thickened and dark, 1–3 µm wide. Conidia solitary, occasionally in simple or branched chains, filiform to cylindrical, straight or curved, shorter conidia obclavate, obconically truncate at the base with a plane and dark hilum (1–2 apical hila on catenate conidia), obtuse to rounded at the apex, 27–112 µm

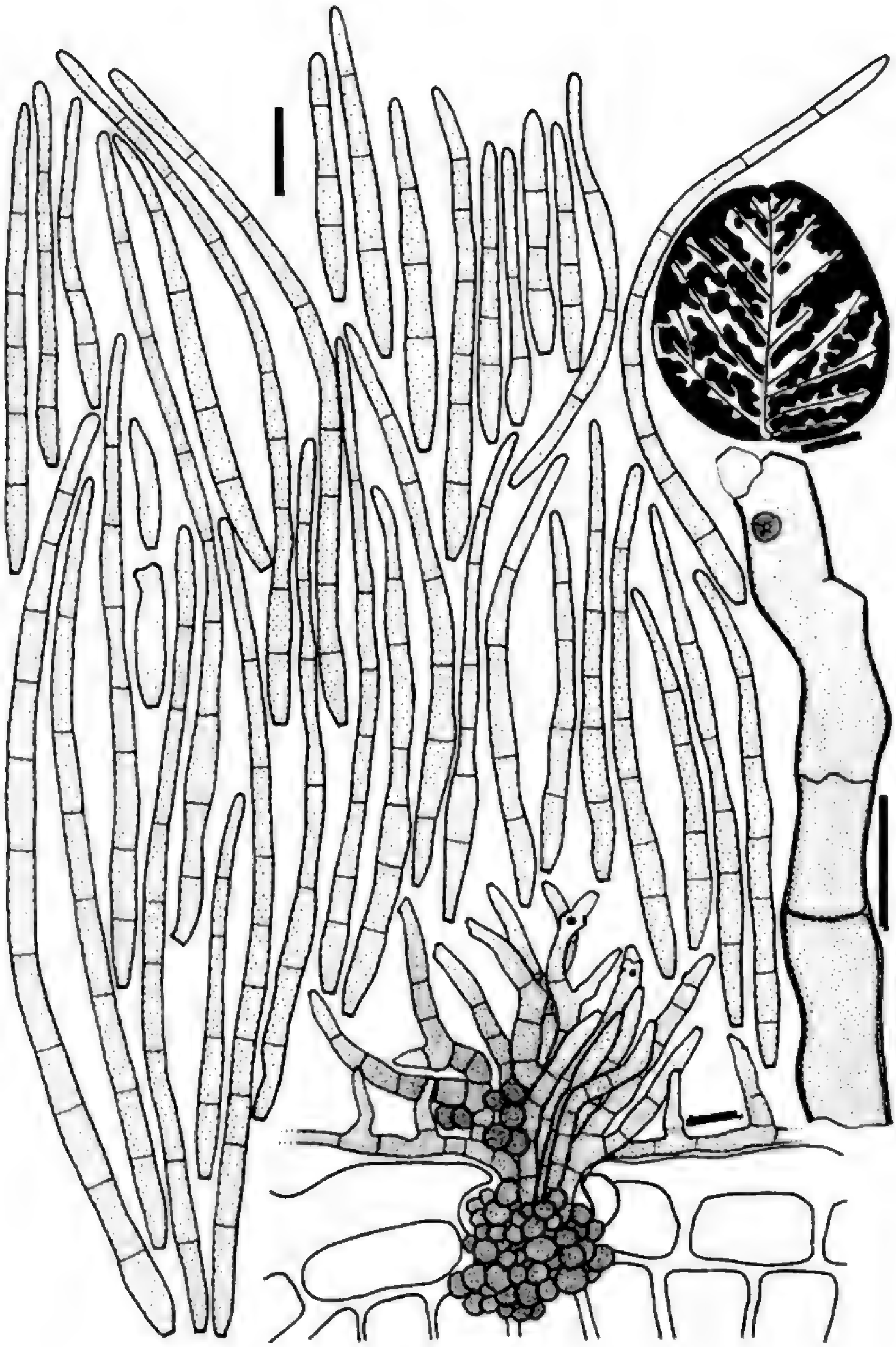

Fig. 4. *Passalora chamaecristae-orbiculatae* on *Chamaecrista orbiculata*. Extensive coalescent lesions on a leaflet (top right) (bar = 10 mm); a representative sample of conidia (bar = 10 μm) on top of a fascicle of branched superficial mycelium and conidiophores (bar = 10 μm); detail of the conidiophore and conidiogenous cell to the right (bar = 5μm). Based on the holotype (UB Mycol. Col. 5550).

long, 2–3 µm diam. at the widest part, 1–2 µm at the base and near the apex, 2–11-septate, light olivaceous, smooth, thin-walled.

COMMENT: Several *Passalora* species are known on hosts belonging to the *Caesalpinioideae*, but most of them belong to other morphological sections. *Passalora aenea* (= *Cercosporidium cassiae*) widespread on *Cassia*, *Chamaecrista* and *Senna* spp. (Deighton 1967, Brown & Morgan-Jones 1977, Crous & Braun 2003), *P. bauhiniicola* U. Braun on *Bauhinia benthamiana* in Venezuela (Braun 2001), *P. cercidicola* (Ellis) U. Braun on *Cercis* spp. in North America (Chupp 1954, Crous & Braun 2003), *P. chamaecristae* (Ellis & Kellerm.) U. Braun on *Cassia* s. lat. spp. in North America (Brown & Morgan-Jones 1977) and *P. schizolobii* M.J. Wingf. & Crous on *Schizolobium parahyba* in Ecuador (Wingfield et al. 2006), belong to section *Passalora*, i.e. superficial hyphae with solitary conidiophores are lacking. *Passalora bauhiniigena* U. Braun & Crous on *Bauhinia vahlii* in India (Crous & Braun 2003).

Passalora. caesalpiniae (Bhalla, A.K. Sarbhoy, M. Kulshr. & K.P.S. Kushwaha) U. Braun, Dianese & A. Hern.-Gut., **comb. nov.**

MYCOBANK, MB 512220

Bas.: *Phaeoramularia caesalpiniae* K. Bhalla, A.K. Sarbhoy, M. Kulshrestha & K.P.S. Kushwaha, Microbiol. Res. 156: 107, 2001.

On *Caesalpinia bonducella* in India (Bhalla et al. 2001) and *P. occidentalis* (Cooke) U. Braun, widespread on species of *Cassia* s. lat. (Chupp 1954, Crous & Braun 2003) are phaeoramularia-like, i.e. without superficial hyphae and solitary conidiophores, but with fasciculate conidiophores and catenate conidia. *Passalora greciana* (Syd.) U. Braun & Crous on *Cassia oxyphylla* in Central America (Chupp 1954, Brown & Morgan-Jones 1977, Crous & Braun 2003) is the only species comparable with the new *P. chamaecristae-orbiculatae*, but it is distinguished from the latter species by lacking lesions, consistently solitary, wider conidiophores, 5–7 µm diam., and wider conidia, 6–8 µm diam. (Brown & Morgan-Jones 1977). *Passalora bauhiniae* (Ellis & Everh.) U. Braun & Crous on *Bauhinia divaricata* in the USA (Braun 1998, Crous & Braun 2003) is another species of sect. *Mycovellosiella*, which is, however, quite distinct by having consistently solitary conidiophores and catenate, much smaller conidia, 10–25 × 2–5 µm, with (0–)1–2(–3) septa.

PASSALORA SECT. *PASSALORA*

Passalora chamaecristicola A. Hern.-Gut. & Dianese, **sp. nov.** FIG. 5

MYCOBANK, MB 512210

Passalorae bauhiniicolae *similis, sed conidiophoris longioribus, 66–131 µm, conidiis 0–5-septatis, tenuitunicatis, sed septis incrassatis.*

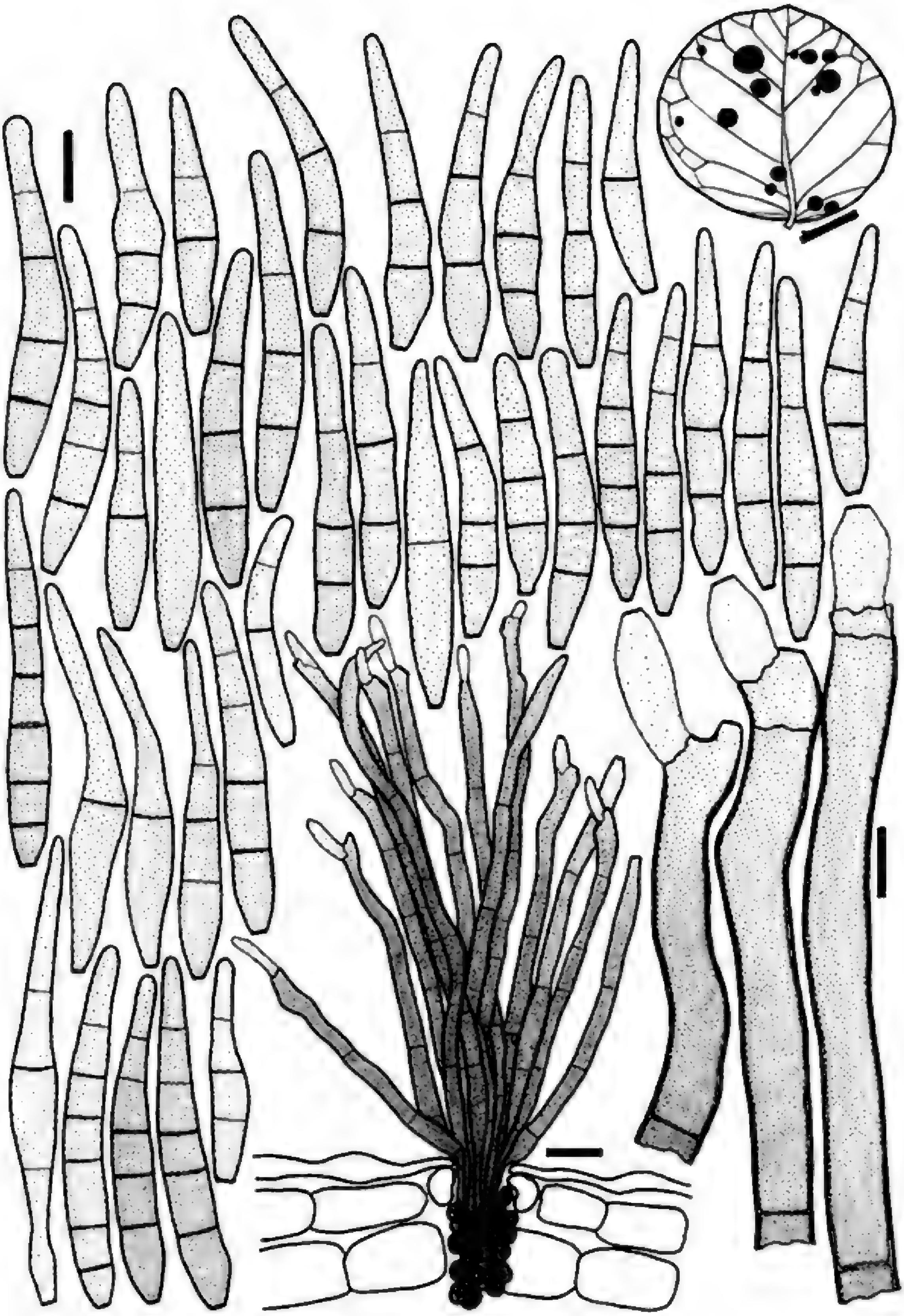

Fig. 5. *Passalora chamaecristicola* on *Chamaecrista orbiculata.* Circular leaf spots on a leaflet (bar = 10mm); sample of conidia (bar = 10 µm) on top of a fascicle of stomatal conidiophores originated from a substomatal stroma (bar = 10 µm); detail of the shape and proliferation of the integrate conidiogenous cells (bar = 5µm). Based on the holotype (UB Mycol. Col. 3682).

Specimens examined: **BRAZIL. Goiás**: Pirenópolis, Hotel Fazenda Pousada dos Pirineus, on living leaves of *Chamaecrista orbiculata*, 25 Apr 1993, *leg J.C. Dianese* 807, **holotype** (UB Mycol. Col. 3682). **Distrito Federal**: Planaltina, Estação Ecológica Águas Emendadas, on living leaves of *Chamaecrista orbiculata*, *leg A.S. Alves*, 6 Mar 1995, **paratype** (UB Mycol. Col. 7411 and 8639); 5 Mar 1997, *leg M. Sanchez* 2397 **paratype** (UB Mycol. Col. 13642).

Etymology: *chamaecristicola*, i.e. inhabiting *Chamaecrista*.

Lesions 1–5 mm diam., amphigenous, circular, sometimes coalescent, dark brown, surrounded by a yellowish halo. Colonies amphigenous, caespitose, dark brown. Stromata moderately developed, 20–53 µm diam., textura globosa, substomatal. Conidiophores loosely fasciculate, emerging directly from the substomatal stroma, divergent, slightly curved, 66–131 µm long, 4–6 µm diam. at the widest part, 3–5-septate, brown, smooth, with annellate structures formed by enteroblastic, monopodial rejuvenation of the conidiophores. Conidiogenous cells terminal, integrate, polyblastic, sympodial, sometimes geniculate, slightly pigmented, light brown; *scars* slightly prominent, thickened and somewhat darkened, 3–5 µm wide. Conidia solitary, slightly curved, straight, obclavate or cylindrical, obconically truncate to truncate at the base, with a slightly pigmented hilum, rounded at the apex, 31–65 µm long, 4–7 µm diam. at the widest part, 2–3 µm at the base, 2–4 µm near the apex, light brown, thin-walled, smooth, but aseptate or 1–5-septate, with up to three thick septa, olivaceous to brown.

Comment: Due to lacking superficial mycelium, conspicuous conidiogenous loci and pigmented, solitary conidia, the new species on *Chamaecrista orbiculata* has to be placed in *Passalora* sect. *Passalora*, and is morphologically close to *P. bauhiniicola* (Braun 2001), described from Venezuela on *Bauhinia benthamiana*. However, the latter species differs from *P. chamaecristicola* in having much shorter conidiophores, 30–70 µm long, with 3–8 unthickened septa. *P. cercidicola*, another species of sect. *Passalora*, possesses similar conidia, but the conidial septa are thin-walled and the conidiophores are much longer, up to 300 µm (Chupp 1954). *Passalora schizolobii* is quite distinct by its much narrower conidia, 3–4 µm wide (Wingfield et al. 2006), and *P. aenea* has much wider conidia, ranging from 8 to 12 µm (Deighton 1967, Brown & Morgan-Jones 1977). *Passalora chamaecristae* is distinguished from the new species by its much shorter conidiophores, 15–70 µm long, subhyaline to very pale brownish conidia and lacking stromata. Furthermore, *P. chamaecristicola* is characterized by conidiophores with annellate structures formed by enteroblastic, monopodial rejuvenation, which are lacking in all comparable *Passalora* species on hosts of the *Caesalpiniaceae*.

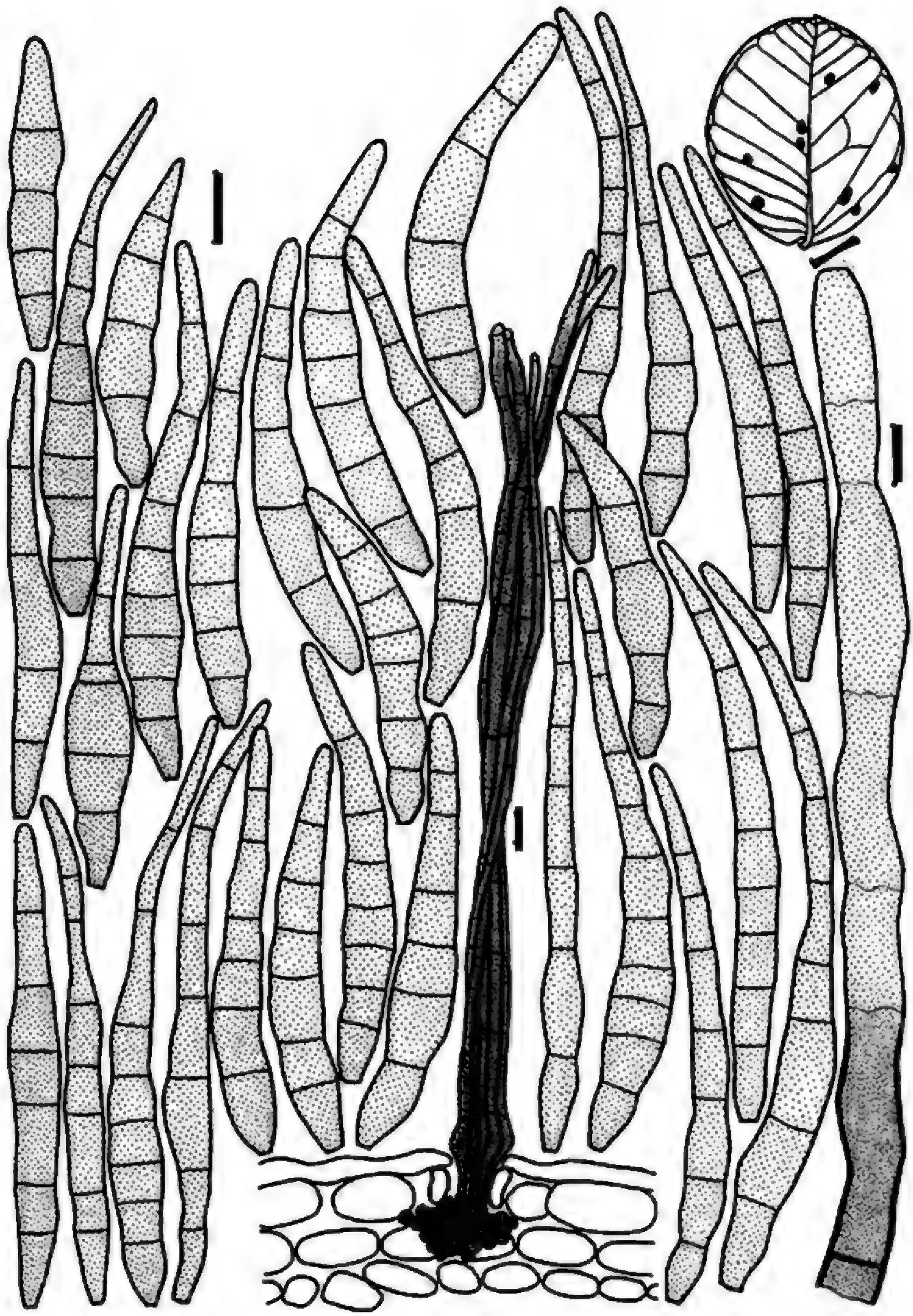

Fig. 6. *Pseudocercospora exilis* on *Chamaecrista orbiculata.* Circular leaf spots on a leaflet (bar = 10 mm); sample of conidia with inconspicuous conidiogenous loci (bar = 10 μm) on top of a synnematous fascicle of stomatal conidiophores originated from a substomatal stroma (bar = 10 μm); detailed view of a conidiogenous cells (bar = 5μm). (UB Mycol. Col. 1477).

Pseudocercospora

Pseudocercospora exilis A. Hern.-Gut. & Dianese, **sp. nov.** FIG. 6

MYCOBANK, MB 512212

Pseudocercosporae caesalpiniicolae *similis, sed synnematibus longioribus et angustioribus, 149–332 × 7–23 µm, et cellulis conidiogenis percurrentibus.*

SPECIMENS EXAMINED: **BRAZIL. DISTRITO FEDERAL:** BRASÍLIA, Península Norte, on living leaves of *Chamaecrista orbiculata*, 9 Aug 1992, *leg J.C. Dianese* 396, **holotype** (UB Mycol. Col. 1477); 11 Jul 1993, *leg J.C. Dianese* 947, **paratype** (UB Mycol. Col. 4084); **MARANHÃO:** BALSAS, 1 km SE from Ribeirãozinho, 04 Abr 1995, *leg M.A. de Freitas* 81, **paratype** (UB Mycol. Col. 8044).

ETYMOLOGY: *exilis*, derived from the thin and delicate synnemata shown by the species.

LESIONS 2–5 mm diam., amphigenous, circular, oval or irregular, light brown to grayish brown in the centre, surrounded by a dark brown margin. COLONIES amphigenous, scattered, dark brown. STROMATA 25–50 µm diam., formed by cells of textura globosa, substomatal. SYNNEMATA parallel and determinate, composed of 5–13 conidiophores, 149–332 µm long or occasionally longer, 7–23 µm diam. immediately above the base. CONIDIOPHORES 5–7 µm diam., 6–14-septate, brown, smooth, thin-walled, synnematous. CONIDIOGENOUS CELLS integrate, terminal, percurrent, light brown; conidiogenous loci inconspicuous, truncate, neither thickened nor pigmented. CONIDIA solitary, curved, straight or slightly flexuous, obclavate, narrowly obclavate or fusoid; obconically truncate at the base, with an unthickened hilum; rounded to broadly rounded at the apex, 38–103 µm long, 6–9 µm diam. at the widest part, 2–3 µm at the base, 2–3 µm near the apex, 4–10-septate, sometimes constricted at some of the septa, light brown to light olivaceous-brown, smooth, thin-walled.

COMMENT: Based on unthickened, non-pigmented conidiogenous loci and conidial hila, this species has to be assigned to *Pseudocercospora*. Due to the structure of the conidiomata, it resembles *P. vitis*, the type species, characterized by conidiophores aggregated in true synnemata. However, the new species differs from all synnematous *Pseudocercospora* spp. on *Leguminosae* s. lat. in having very slender synnemata and, above all, percurrently proliferating conidiogenous cells. Percurrent conidiogenous cells are above all known from former *Cercostigmina* U. Braun (Braun 1993) species, which are now included in *Pseudocercospora* (Crous & Braun 2003). Only few synnematous *Pseudocercospora* species are known on hosts of the *Caesalpinioideae*. *P. chamaecristae* U. Braun & O.F. Freire, described from Brazil on *Chamaecrista* sp. (Braun & Freire 2002) is a similar species, but distinct by its wider synnemata, 120–280 × 15–60 µm, and shorter, only 1–4-septate conidia, 25–35 × 5–8(–10) µm.

A second species, previously referred to as *Phaeoisariopsis*, is known from Brazil on *Caesalpinia bonducellae* (Hennings 1904, Ellis 1976):

Pseudocercospora bonducella (Henn.) U. Braun, Dianese & A. Hern.-Gut. **comb. nov.**

MycoBank, MB 512222

Bas.: *Helminthosporium bonducellae* Henn., Hedwigia 43: 95, 1904.

Syn.: *Phaeoisariopsis bonducellae* (Henn.) Deighton, in Ellis, More Dematiaceous Hyphomycetes: 233, 1976.

Specimens examined: **BRAZIL.** Rio de Janeiro, on living leaves of *Caesalpinia bonduncellae*, *leg Ule* 1077, **holotype** of *H. bonducellae* (B).

Illustration: Ellis (1976: 233, Fig. 173 B).

Due to unthickened, non-pigmented conidiogenous loci and conidial hila, this species is a true *Pseudocercospora*. However, the conidiophores are aggregated in dense fascicles, i.e. they are not synnematous. This species is characterized as follows: Leaf spots amphigenous, subcircular to angular-irregular, 1–5 mm diam., occasionally vein-limited, pale to medium brown, reddish brown, later pale grayish brown, with a narrow reddish brown marginal line, occasionally somewhat raised; caespituli hypophyllous, scattered to dense, dark brown; mycelium internal; stromata small, substomatal, 10–30 µm diam., brown, often somewhat erumpent, cells 2–7 µm diam.; conidiophores in large, more or less dense fascicles, but not in synnemata, 50–180 × 3–8 µm, subcylindrical-filiform to somewhat sinuous or slightly genicuate, unbranched or rarely branched, pale to medium olivaceous-brown, pluriseptate throughout, smooth, thin-walled, wall up to 1 µm wide; conidiogenous cells integrated, terminal, 10–25 µm long, barely to slightly geniculate, conidiogenous loci inconspicuous; conidia solitary, obclavate-cylindrical, (25–)30–110 × (6–)7–9(–10) µm, (1–)3–10-septate, pale to medium olivaceous-brown, thin-walled, smooth, apex obtuse, mostly broadly rounded, base short obconically truncate, hila 2–2.5(–3) µm wide, unthickened, not darkened.

Yen et al. (1982) described *Phaeoisariopsis caesalpiniae* from India, also on *Caesalpinia bonducellae*. Deighton (1990) supposed that this species may be identical with *P. bonducellae*. The re-examinations of type material and numerous additional collections from India showed that the two species are morphologically very similar. However, the Indian fungus is distinct by conidiophores in loose to dense fascicles as well as true synnemata, much narrower conidia, 30–100 × 3–6.5 µm, not constricted at the septa, and somewhat narrower hila, 1–2 µm diam. Therefore, the Indian fungus is considered a separate species, which also belongs in *Pseudocercospora* based on inconspicuous conidiogenous loci:

Pseudocercospora caesalpiniicola U. Braun, Dianese & A. Hern.-Gut., **nom. nov.**
MycoBank, MB 512238
Bas.: *Phaeoisariopsis caesalpiniae* J.M. Yen, A.K. Kar & B.K. Das, Mycotaxon 16: 84, 1982, non *Pseudocercospora caesalpiniae* Goh & W.H. Hsieh, 1989.

Specimens examined: **INDIA. Bengal**: Nadia, Palpara, on *Caesalpinia bonducellae*, 25 Nov 1979, B.K. Das, **isotype** of *P. caesalpiniae* (IMI 37382); **Jabalpur**, Feb 1969, *leg G.P. Agarwal* (IMI 138933); Calcutta, 29 Mar 1979, *leg J.B. Ray* (IMI 237382) and 24 Aug 1978, *leg A.K. Kar* (IMI 231245); **U.P.**, Gorakhpur, 25 Jan 1980, *leg A.K. Singh* (IMI 244863), 29 Jan 1980, *leg A.N. Rai* (IMI 246391) and Feb 1984, *leg P. Narayan* (IMI 285861); on *Caesalpinia* '*sepiaria*' (probably *C. bonducellae*), **Jabalpur**, Aug 1964, *leg V.P. Sahni* (IMI 108639).

All Indian collections agree well with the original description and illustration of this species by Yen et al. (1982). On account of rather slender synnemata, usually monoblastic, non-geniculate conidiogenous cells and very similar conidia, *P. caesalpiniicola* is morphologically very close to *P. exilis*, but the synnemata are wider, composed of up to 35 conidiophores, and percurrent proliferations of the conidiogenous cells have not been observed.

Phaeoisariopsis indica (Subram.) Deighton (Ellis 1976) on an unknown leguminous host in India with similar synnemata and conidia belongs probably in *Pseudocercospora*, but the synnemata are wider and the conidiogenous cells are sympodial.

Pseudocercospora luzianiensis A. Hern.-Gut. & Dianese, **sp. nov.** Fig. 7
MycoBank MB 512213

Pseudocercosporae caesalpiniicolae *similis, sed synnematibus longioribus, 315–600 μm, et cellulis conidiogenis sympodialiter proliferantibus.*

Specimen examined: **BRAZIL. Goiás**: Luziânia, Fazenda Roberto Ronald, on living leaves of *Chamaecrista setosa*, 10 Jun 1993, *leg J.C. Dianese* 884, **holotype** (UB Mycol. Col. 3891).

Etymology: *luzianiensis*, derived from Luziânia, the place of collection.

Lesions 0.5–2 mm diam., amphigenous, circular or irregular, dark brown, without a defined delimiting margin. Colonies exclusively hypophyllous, generally 1–2 synnemata in each lesion, dark brown. Stromata 50–88 μm diam., well-developed, formed by cells of textura globosa, substomatal, light brown. Synnemata very compacted, textura parallela, determinate, 315–600 μm long, 12–47 μm diam. immediately above the base, formed by 6–41 conidiophores, dark brown. Individual conidiophores 141–600 μm long, 3–5 μm diam. at the widest part, 8–21-septate, with enteroblastic, monopodial rejuvenation, leaving annellate structures, light brown to light olivaceous, smooth, thin-walled. Conidiogenous cells integrated, terminal or intercalary, mono- or polyblastic, sympodial, geniculate, conidiogenous loci truncate, unthickened, but somewhat pigmented. Conidia solitary, curved, sometimes straight or flexuous, obclavate, cylindrical or fusoid; obconically truncated at the base

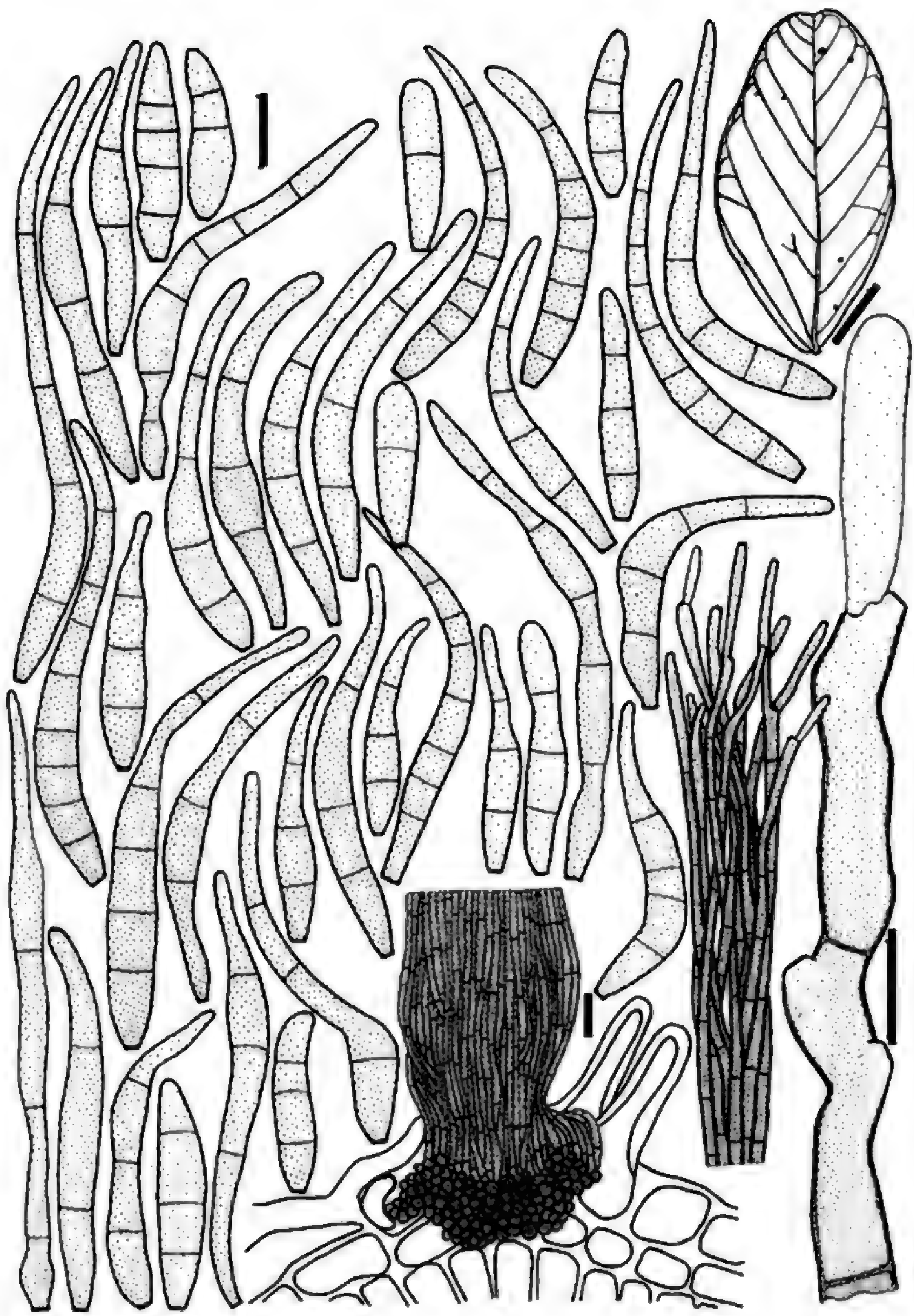

Fig. 7. *Pseudocercospora luzianiensis* on *Chamaecrista setosa.* Small leaf spots on a leaflet (bar = 10 mm); sample of conidia with inconspicuous conidiogenus loci (bar = 10 μm) on top of a synnematous fascicle of stomatal conidiophores originated from a substomatal stroma (bar = 10 μm); detailed view of a conidiogenous cells (bar = 5μm). (UB Mycol. Col. 3891).

with unthickened, but dark hilum; obtuse, rounded to broadly rounded at the apex; 22–89 µm long, 5–7 µm diam. at the widest part, 2–3 µm at the base, 2–5 µm near the apex, 1–8-septate, light olivaceous to subhyaline, smooth, thin-walled.

COMMENT: *Pseudocercospora luzianiensis* is a synnematous, phaeoisariopsis-like hyphomycete. The conidiogenous cells are distinctly geniculate caused by sympodial proliferation. The structure of the conspicuous conidiogenous loci is somewhat intermediate between *Passalora* and *Pseudocercospora*. The loci are truncate, rigid, somewhat darkened, but not distinctly thickened. These are structures comparable with the loci of *P. vitis*, the type species of *Pseudocercospora*. Therefore, this fungus is treated as a new species of the latter genus. Synnematous *Passalora* species on hosts of the *Caesalpinioideae* are unknown, but a few synnematous species have been assigned to *Pseudocercospora*. The new species *P. exilis* is quite distinct from all of them by its very slender synnemata and percurrent conidiogenous cells. *Pseudocercospora chamaecristae* (Braun & Freire 2002) is easily distinguishable by its much shorter conidiophores, only up to 280 µm long, and shorter, 1–4-septate conidia, 25–35 × 5–8(–10) µm. However, *P. caesalpiniicola* is morphologically rather close to *P. luzianiensis*, but differs in having much shorter conidiophores, only up to 215 µm in length, and non-geniculate, mostly monoblastic conidiogenous cells.

Pseudocercospora chamaecristigena A. Hern.-Gut. & Dianese, **sp. nov.** FIG. 8

MYCOBANK, MB 512214

Pseudocercosporae luzianiensis *similis, sed synnematibus brevioribus (208–335 µm), conidiophoris ad basim saepe inflatis, conidiis crassitunicatis et septis incrassatis. Differt a* P. caesalpiniicola *synnematibus longioribus (208–335 µm), conidiophoris ad basim saepe inflatis, cellulis conidiogenis sympodialiter proliferantibus, conidiis crassitunicatis et septis incrassatis.*

SPECIMEN EXAMINED: **BRAZIL. MATO GROSSO**: CUIABÁ, Parque Nacional Chapada dos Guimarães, on living leaves of *Chamaecrista* sp., 11 Apr 1996, l*eg M. Sanchez* 1656, **holotype** (UB Mycol. Col. 11427).

ETYMOLOGY: *chamaecristigena*, i.e. inhabiting *Chamaecrista.*

LESIONS 2–7 mm diam., amphigenous, oval or irregular, grayish brown, surrounded by a dark brown margin. COLONIES amphigenous, scattered, dark brown. STROMATA 35–83 µm diam., substomatal, formed by cells of textura globosa. CONIDIOPHORES in synnemata of textura parallela, determinate, 208–335 µm long, 20–83 µm diam. immediately above the base, composed by 16–65 individual conidiophores, simple, flexuous, cylindrical, 3–5 µm diam. at the widest part, often characteristically dilated just above the leaf surface, 4–12-septate, brown or light brown, smooth, thin-walled. CONIDIOGENOUS CELLS integrated, terminal, mainly monoblastic, sometimes polyblastic, sympodial,

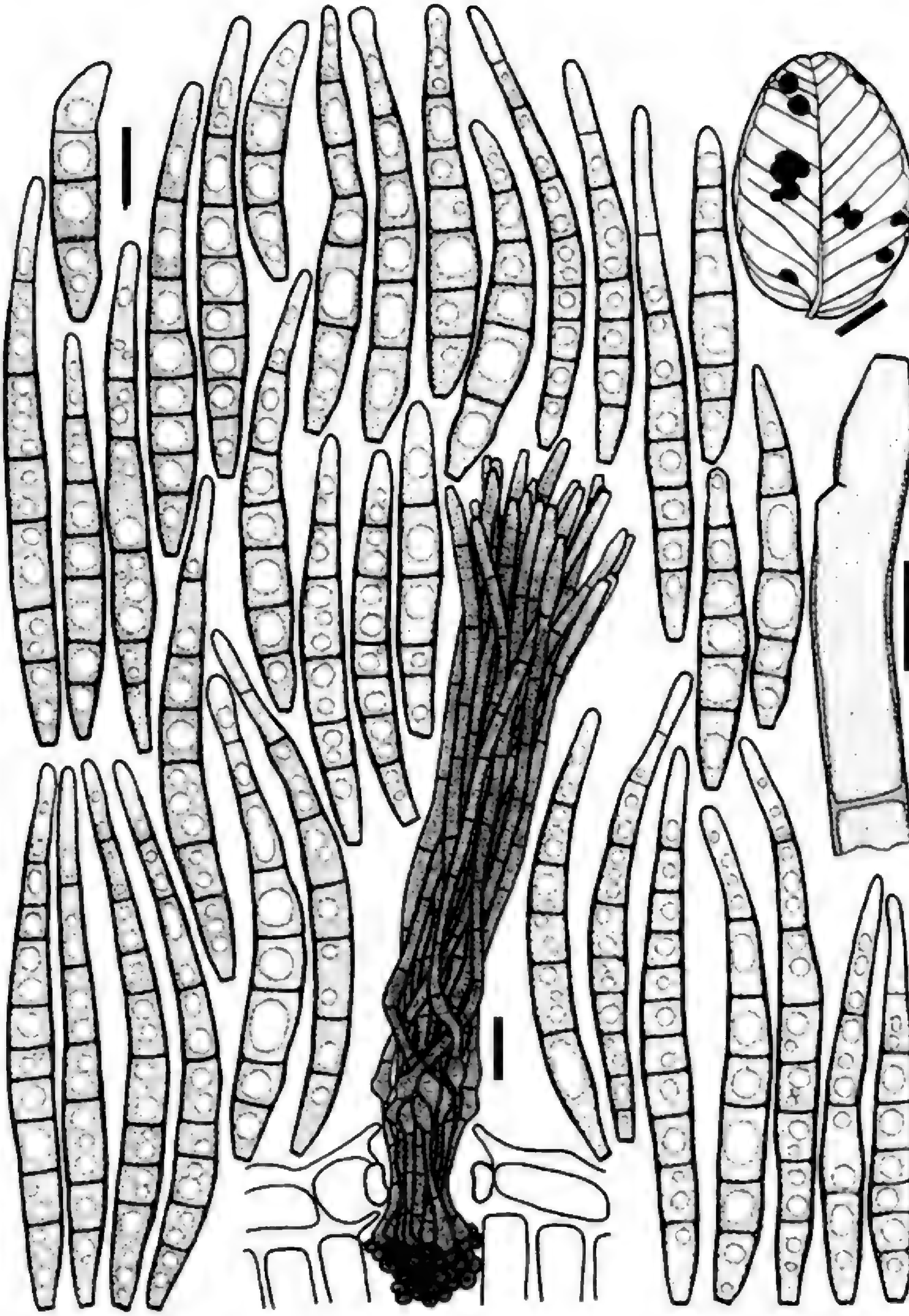

Fig. 8. *Pseudocercospora chamaecristigena* on *Chamaecrista* sp. Large coalescent circular or irregular leaf spots on a leaflet (bar = 10 mm); sample of thick walled conidia and inconspicuous conidiogenus loci (bar = 10 μm) on top of a synnematous fascicle of stomatal conidiophores originated from a substomatal stroma (bar = 10 μm); detailed view of a conidiogenous cell (bar = 5μm). (UB Mycol. Col.

scars not very prominent, neither distinctly thickened nor pigmented. CONIDIA solitary, straight or slightly curved, obclavate, sometimes cylindrical, obconically truncate at the base, with an unthickened and only barely pigmented hilum, rounded to broadly rounded at the apex, 35–79 µm long, 5–8 µm diam. at the widest part, 2–3 µm at the base, 2–4 µm near the apex, 3–10-septate, walls and septa somewhat thickened, light olivaceous-brown, smooth.

COMMENT: *Pseudocercospora chamaecristigena* is distinguished from all other synnematous *Pseudocercospora* spp. on hosts of the *Caesalpinioideae* by its conidiophores which are enlarged at the very base. Furthermore, *P. luzianiensis* has much longer synnemata, up to 600 µm, and thin-walled conidia with thin septa. *Pseudocercospora caesalpiniicola* has shorter synnemata, only up to about 200 µm, non-geniculate conidiogenous cells and thin-walled conidia, and *P. chamaecristae* is quite distinct by its much shorter, thin-walled, 1–4-septate conidia, 25–35 × 5–8(–10) µm.

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Yen JM, Kar AK, Das BK. 1982. Studies on hyphomycetes from West Bengal, India, III. *Cercospora* and allied genera of West Bengal. Mycotaxon 16(1): 80–95.

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Discomycetes Exsiccati — Fascicles 5 and 6

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Abstract — Fifty discomycete specimens are issued and deposited in 14 international herbaria. These include 18 members of the *Helotiales* (including isotypes of *Lambertella subrenispora*) and 26 members of the *Pezizales.* A redetermination of one collection as *Trichoglossum rasum* is a correction for the species name *T. wrightii* reported earlier from Bermuda. In 6 cases 2 collections of the same species are issued for comparative purposes. One of the 2 collections of *Scutellinia setosa* may be an undescribed taxon. Several collections are new distributional records.

Keywords — North America, Europe, Macaronesia, Caribbean Islands, Asia

Fig. 1 (below) is a copy of the label of the first of 50 specimens being issued in two fascicles of Discomycetes Exsiccati, a continuation of the series last published by Korf & Gruff (1981). To save space, only the data for specimens 102–150 are printed here.

Discomycetes Exsiccati

Department of Plant Pathology & Plant-Microbe Biology,
Cornell University. Richard P. Korf & Robert Dirig, Editors

101. *Bisporella confluens* (Sacc.) Korf & Bujak., Agarica 6: 306. 1985.
On decorticated wood of *Carpinus caroliniana.*
Hendershot Gulf (the "Lost Gorge"), Alpine, New York

The type specimen tied to this name is the type specimen of *Peziza confluens* Schwein., a later homonym. See the discussion in Korf & Bujakiewicz's paper and in Korf, R.P. 2007. On the genus *Solenopezia* (Fungi, *Lachnaceae*): *Peziza solenia* and ICBN Art. 58 — a sleeping dog bites back. Bol. Soc. Argent. Bot 42: 29-32.

Leg,: H.H. Burdsall 10.x.1966.
Det.: R.P.K.

Fig. 1. A typical label at full size, shown for specimen 101.

Fascicle Five

102. ***Bisporella scolochloae*** (De Not.) Spooner, in Kirk & Spooner, Kew Bull. 38: 557. 1984.

On bamboo. Just north of San Andrés at km. mark 17.8, Hierro, Canary Islands, Spain.

Leg.: R.P.K., R. Fogel, G.L. Hennebert & L.M. Kohn. 7.i.1977.
Det.: R.P.K.

103. ***Chlorociboria aeruginosa*** (Oeder : Fr.) Seaver ex C.S. Ramamurthi, Korf & L.R. Batra, Mycologia 49: 859. 1958 [1957].

On green-stained wood. Woods along road between Chuzenji Temple and Tanukikubo, Lake Chuzenji, Nikko, Tochigi Pref., Honshu, Japan.

Leg.: S. Imai & R.P.K. 9.x.1963.
Det.: R.P.K.

104. ***Chlorosplenium chlora*** (Schwein. : Fr.) M.A. Curtis, in Sprague, Proc. Boston Soc. nat. Hist. 5: 330. 1856.

On wood. Mycological Society of America foray, Brown County State Park, near Bloomington, Indiana.

Leg.: R.P.K. 23.viii.1958.
Det.: R.P.K.

105. ***Crocicreas culmicola*** (Desm.) S.E. Carp., Brittonia 32: 269. 1980.

On culms and glumes of *Poaceae* tribe *Hordeae* (host. det. by P. Hyypio). Bergen Swamp, near Rochester, New York.

Leg.: M.J. Rosenberg, W.C. Denison, R.L. Shaffer, M.A. Rosinski & R.P.K. 5.vii.1955.
Det.: R.P.K. (Confirmed: S.E. Carpenter)

106. ***Cudonia lutea*** (Peck) Sacc., in Saccardo & Berlese, Atti R. Ist. Veneto Sci. Lett. Arti, Ser. 6, 3: 725. 1885.

On soil. In pine grove near road. Upper Buttermilk Falls State Park, Ithaca, New York.

Leg.: W.C. Denison & M.A. Rosinski 22.ix.1954.
Det.: R.P.K.

107. ***Holwaya mucida*** (Schulzer) Korf & Abawi subsp. ***mucida,*** Can. J. Bot. 49: 1880. 1971.

On rotted log of *Tilia* sp. Lloyd-Cornell Preserve, Slaterville, New York.

Also present is its anamorph, *Crinula caliciiformis* (Fr. : Fr.) Fr. var. *caliciiformis,* Syst. mycol. 1: 493. 1821.

Leg.: R.P.K. et al. 25.ix.1954
Det.: R.P.K.

108. ***Lambertella subrenispora*** Korf & W.Y. Zhuang,
Mycotaxon 24: 367. 1985. **ISOTYPE**

On stems of *Artemisia* sp. Fujimi-mura, Mt. Akaji, Gumma Pref., Honshu, Japan.

Leg.: International Mycological Congress S. Imai Workshop participants. 24.viii.1983.
Det.: R.P.K. & W.Y. Zhuang

109. ***Pezicula cinnamomea*** (DC. : Fr.) Sacc. f. ***cinnamomea***,
Syll. Fung. 8: 311. 1889.

On branches of *Viburnum nudum* var. *cassinoides* killed by insects. Exe Island, Big Rideau Lake, Ontario. Canada.

Leg.: R.P.K. 30.iv.1979.
Det.: R.P.K.

110. ***Vibrissea flavovirens*** (Pers. : Fr.) Korf & J.R. Dixon,
in Korf, Mycotaxon 1: 134. 1974.

On *Quercus* wood in stream. Mycolodge woods, Thomas Road, Town of Caroline, Tompkins County, New York.

Leg.: A. Sánchez & D.H. Pfister. 20.vi.1968.
Det.: R.P.K.

111. ***Gelatinopsis geoglossi*** (Ellis & Everh.) Rambold & Triebel,
Notes R. bot. Gard. Edinb. 46: 377. 1990.

On hymenium of *Trichoglossum octopartitum* Mains [see Disc. Exs. #116, same collection]. On trail between Woodcutter's Gap and ruins of Major Wallin's House, vicinity of Newcastle, Portland Parish, Jamaica.

Leg.: R.P.K., J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds,
A.Y. Rossman & G.J. Samuels. 11.i.1971.
Det.: R.P.K.

112. ***Geoglossum simile*** Peck, Bull. Soc. Nat. Sci. 1: 70. 1873.

On soil. 3 miles north of Saranac Lake on Forest Home Road, Franklin County, New York.

Leg.: D. Punter & L.D. Taylor. 11.ix.1965.
Det.: R.P.K.

113. ***Geoglossum umbratile*** Sacc. var. ***umbratile,*** Michelia 1: 444. 1878.

On soil in roadside ditch. Las Mercedes, 1.5 km. toward El Moquinal, on road from La Laguna to Pico del Inglés. Tenerife, Canary Islands, Spain.

Leg.: R.P.K., W.C. Denison, L.M. Kohn & M.A. Sherwood. 4.i.1976.
Det.: R.P.K.

114. ***Trichoglossum hirsutum*** (Pers. : Fr.) Boud. var. ***hirsutum,*** Hist. Class. Discom. Eur. p. 86. 1907.

On soil. 4 km. east of Bailadero, Punta de Anaga, Tenerife, Canary Islands, Spain.

Leg,: R.P.K., R. Fogel, G.L. Hennebert & L.M. Kohn. 31.xii.1976.
Det.: R.P.K.

115. ***Trichoglossum hirsutum*** (Pers. : Fr.) Boud. var. ***hirsutum,*** Hist. Class. Discom. Eur. p. 86. 1907.

On *Sphagnum* sp. Chräenriet bei Watt, Gemeinde Regensdorf, Kanton Zürich, Switzerland.

Leg,: E. Müller & R.A. Shoemaker. 12.ix.1961.
Det.: R.P.K.

116. ***Trichoglossum octopartitum*** Mains, Amer. J. Bot. 27: 325. 1940. [see Disc. Exs. #111, same collection]

On soil. On trail between Woodcutter's Gap and ruins of Major Wallin's House, vicinity of Newcastle, Portland Parish, Jamaica.

Leg.: R.P.K., J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds, A.Y. Rossman & G.J. Samuels. 11.i.1971.
Det.: R.P.K.

117. ***Trichoglossum rasum*** Pat., Bull. Soc. Mycol. France 25: 130. 1909.

On hillside among *Stenotaphrum* (grass). Fruitlands, Warwick, Bermuda.

This collection reported by Waterston, Bull. Dept. Agr. Bermuda 23: 128. 1947 as *T. wrightii* [E.J.] Durand.

Leg.: H.H. Whetzel, B.M.L. Ogilvie & F.J. Seaver. 15.i.1926.
Det.: R.P.K.

118. ***Trichoglossum walteri*** (Berk.) E.J. Durand var. *walteri,* Annales Mycol. 6: 440. 1908

On the ground. Pack Forest, Adirondack Mountains, near Warrensburg, New York.

Leg.: S.J. Smith, J. Moisey & al. 2.x.1955.
Det.: R.P.K.

119. ***Stamnaria americana*** Massee & Morgan, in Morgan, J. Mycol. 8: 183. 1902.

On diseased portions of standing stems of *Equisetum debile.* Tjibeureum swamps, Mt. Panagro, Java, Indonesia.

This appears to be a major extension of the range of this species, which differs strongly from the apparently saprophytic (or endophytic?) type species of the genus. Molecular studies would help determine the correct generic placement.

Leg.: M.A. Rifai & R.P.K. 20.xii.1961.
Det.: R.P.K.

120. ***Coprotus aurora*** (P. Crouan & H. Crouan) K.S. Thind & Waraitch, Res. Bull. Punjab Univ., n.s. 21: 145. 1971 [1970].

On cow dung. Lloyd-Cornell Preserve, McLean, New York.

Leg.: L.R. Batra & R.P.K. 13.v.1957.
Det.: R.P.K.

121. ***Coprotus disculus*** Kimbr., Luck-Allen & Cain, Can. J. Bot. 50: 962. 1972.

On cow dung. Along Cane River and slope of Good Hope Mountain, near Kingston, St. Andrew Parish, Jamaica.

Leg.: R.P.K., J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds, A.Y. Rossman & G.J. Samuels. 12.i.1971.
Det.: D.H. Pfister.

122. ***Coprotus duplus*** Kimbr., Luck-Allen & Cain, Can. J. Bot. 50: 963. 1972.

On dung of (? skunk). University Forest, near Dorset, Ontario, Canada.

Leg.: Norton Miller. 8.xi.1962.
Det.: R.P.K.

123. ***Coprotus glaucellus*** (Rehm) Kimbr., Am. J. Bot. 54: 22. 1967.

On deer dung. Pack Forest, Warrensburg, New York.

Leg,: R.P.K. & K. Tubaki. 15.vii.1960.
Det.: R.P.K.

124. ***Miladina lecithina*** (Cooke) Svrček, Česká Mykol. 26: 214. 1972.

On rotten wood. In southern inlet stream, Mud Pond, Lloyd-Cornell Preserve, McLean, New York.

Leg,: R.T. Moore, J.W. Kimbrough & R.P.K. 15.vii.1960.
Det.: R.P.K.

125. ***Peziza atrovinosa*** Cooke & W.R. Gerard, Bull. Buffalo Acad. Sci. 1875: 288. 1875.

On soil of bank along dirt road. Dryden, New York.

Leg.: W.C. Denison (#1207) and family. 22.vii.1956.
Det.: R.P.K.

Fascicle Six

126. ***Byssonectria fusispora*** (Berk. & Broome) Rogerson & Korf, in Korf, Phytologia 21: 202. 1971.

On soil. Hendershot Gulf (the "Lost Gorge"), stage 27, Alpine, New York.

Leg.: P. Kable, R.P.K., et al. 22.iv.1963.
Det.: R.P.K.

127. ***Cheilymenia granulata*** var. ***microspora*** (Rehm) J. Moravec, World Monogr. of the genus *Cheilymenia,* p. 71. 2005.

On cow dung. St. Thomas Parish, trail between Barretts Gap and Cornpuss Gap, elev. 488-610 m., Jamaica.

Leg.: R.P.K., J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds, A.Y. Rossman & G.J. Samuels. (CUP-MJ-503) 15.i.1971.
Det.: J. Moravec.

128. ***Cheilymenia stercorea*** (F.H. Wigg. : Fr.) Boud. f. ***stercorea,*** Icones Mycologicae Liste Prélim. p. [4]. 1904.

On horse dung. Woods, mixed *Pinus nigra* subsp. *laricio* and *Fagus,* below Vezzavona railroad station, elev. 850 m., Corsica, France.

Leg.: R.P.K. & V. Demoulin. 9.x.1972.
Det.: R.P.K.

129. ***Thelebolus stercoreus*** Tode : Fr., Fungi. mecklenb. sel. 1: 41. 1790.

On dung of roe deer. Along roadside in *Fagus* forest. Karrebakstorp Skov, 10 km SW of Nastved, Denmark.

Leg.: H. Dissing. 7.x.1978.
Det.: H. Dissing.

130. ***Lasiobolus cuniculi*** Velen., Monogr. Discom. Bohem. 1: 363. 1934.

On reindeer dung. Lakes above treeline, between Ankerlia and Raisdoud-darhaldde, Troms Fylke, Norway.

Leg.: S. Sivertsen, H. Dissing & R.P.K. (CUP-59063) 13.viii.1978.
Det.: R.P.K.

131. ***Octospora humosa*** (Fr. : Fr.) Dennis, British Cup Fungi & their Allies, p. 33: 1960.

On wet soil among mosses. University Forest near Dorset. Ontario, Canada.

Leg.: R.P.K. et al. 9.ix.1962.
Det.: R.P.K.

132. ***Octospora humosa*** (Fr. : Fr.) Dennis, British Cup Fungi & their Allies, p. 33: 1960.

Among *Polytrichum* mosses in sand. Finnmark Fylke, ca. 1 km. S of Suolovuobme, Norway.

Leg.: S. Sivertsen, H. Dissing & R. P. K. (CUP-59100) 15.viii.1978.
Det.: R.P.K.

133. ***Pachyella adnata*** (Berk. & M.A. Curtis) Pfister, Can. J. Bot. 51: 2011. 1974 [1973].

On fallen trunk of *Cecropia peltata* L. Along trail from km. 10.4 on Rte. 191 to falls of Rio de la Mina, El Yunque, Puerto Rico, elev. ca. 500 m.

Leg.: R.P.K., J.B. Benson, J.R. Dixon, J.H. Haines, D.H. Pfister, A.Y. Rossman, A. Sanchez & L.E. Skog. (CUP-PR-4007) 10.vi.1970.
Det.: R.P.K.

134. ***Pachyella clypeata*** (Schwein. : Fr.) Le Gal, Revue Mycol. Paris 18: 123. 1953.

On mossy wood. Lloyd-Cornell Preserve, McLean, New York.

Leg: J.R. Dixon, D.H. Pfister & P. Fazio. 11.x.1969.
Det.: D.H. Pfister.

135. ***Pachyella clypeata*** (Schwein. : Fr.) Le Gal, Revue Mycol. Paris 18: 123. 1953.

On mossy wood. Lloyd-Cornell Preserve, McLean, New York.

Leg: R.A. Shoemaker, R.L. Shaffer & R.P.K. 2.x.1952.
Det.: R.P.K.

136. ***Pithya vulgaris*** Fuckel, Jb. nassau. Ver. Naturk. 23-24: 317. 1870.

On *Abies* twigs. Beaver Lake, Vancouver Island, B.C., Canada.

Leg.: M.C. Melburn. 20.iv.1957.
Det.: J.W. Groves.

137. ***Pseudorhizina californica*** (W. Phillips) Harmaja, Karstenia 13: 56. 1973.

On mossy soil. Gold Creek Area, Washington (W. of Bonner County, Idaho).

Leg: H. H. Burdsall et al. 7.vii.1964.
Det.: H. H. Burdsall & R.P.K.

138. ***Scutellinia crucipila*** (Cooke & W. Phillips) J. Moravec, Česká Mykol. 38: 149. 1984

On mud in tractor ruts. Sorø Sønderskov, N of the road, Sjaelland, Denmark.

Leg.: U. Søchting, H. Dissing & R.P.K. (CUP-59427) 31.viii.1978.
Det. R.P.K.

139. ***Scutellinia crucipila*** (Cooke & W. Phillips) J. Moravec, Česká Mykol. 38: 149. 1984.

On wet soil. Oteren, Storfjord, Troms Fylke, Norway.

Leg.: H. Dissing & R.P.K. (CUP-59053) 13.viii.1978.
Det.: R.P.K.

140. ***Scutellinia setosa*** (Nees : Fr.) Kuntze, Revis. gen. pl. 2: 869. 1891.

On decorticated wood of *Betula alleghaniensis*. Lloyd-Cornell Preserve, Ringwood, New York.

Many apothecia in this collection have short hairs rarely exceeding 350 µm long, and non-collapsing apothecia, resembling specimens distributed in Ellis & Everhart, North American Fungi #2003, issued as *Peziza setosa* Nees. It is possibly an undescribed taxon.

Leg.: R.P. K. (CUP-67876). 14.ix.1975.
Det.: R.P.K.

141. ***Scutellinia setosa*** (Nees : Fr.) Kuntze, Revis. gen. pl. 2: 869. 1891.

On decorticated wood. McCormick Creek State Park, Monroe Co., Indiana. (M.S.A. foray)

Leg.: R.P.K. 21.viii.1958.
Det.: R.P.K.

142. ***Trichophaea brunnea*** (Alb. & Schwein.: Fr.) L.R. Batra, in Batra & Batra, Bull. Univ. Kansas, Sci. 44: 167. 1963.

On originally steam-sterilized soil among mosses and algae in pots with *Betula* seedlings. Cornell University greenhouse, Tower Rd., Ithaca, New York.

Leg.: R.P.K. & R. Stack 31.viii.1978.
Det.: R.P.K.

143. ***Kotlabaea deformis*** (P. Karst.) Svrček, Česká Mykol. 23: 87. 1969.

Among mosses on mud in tractor ruts. Sorø Sønderskov, N of the road, Sjaelland, Denmark.

A *Cheilymenia* sp. also present.

Leg.: U. Søchting, H. Dissing & R.P.K. (CUP-59422) 31.viii.1978.
Det.: R.P.K.

144. ***Lamprospora ovalispora*** (Svrček & Kubička) Eckblad, Nytt Mag. Bot. 15: 42. 1968.

On soil at edge of pond. Loevvajåkka, near Lavajok, along Rana River, Finnmark Fylke, Norway.

Leg.: S. Silvertsen, H. Dissing & R.P.K (CUP-59213) 21.viii.1978.
Det.: R.P.K.

145. ***Melastiza cornubiensis*** (Berk. & Broome) J. Moravec, Mycotaxon 44: 68. 1992.

On sandy roadside. Roeppen, ca. 10 km SE of Varangerbotu, Finnmark Fylke, Norway.

Commonly called *Melastiza chateri* (W.G. Sm.) Boud. or *M. miniata* (Fuckel) Boud. Both are later synonyms of Berkeley and Broome's species.

Leg.: S. Sivertsen, H. Dissing & R.P.K. 20.viii.1978
Det. R.P.K.

146. ***Melastiza rubra*** (L.R. Batra) Maas Geest., Persoonia 4: 417. 1967.

On soil along path. Yiangtaugaou, Xiangschan, Beijing, China.

This specimen was reported from China by R.P. Korf & W.Y. Zhuang, Mycotaxon 22: 502. 1985.

Leg.: R.P.K. & Mycology Dept. group, Academia Sinica (CUP-CH-2289) 4.ix.1981
Det.: R.P.K. & W.Y. Zhuang.

147. ***Melastiza rubra*** (L.R. Batra) Maas Geest., Persoonia 4: 417. 1967.

On sandy flood plain. Suganuna Concession Area, Gumma Pref., Honshu, Japan.

Apparently a new record for Japan.

Leg.: IMC3 workshop group (CUP-JA-3614) 21.viii.1983
Det.: W.Y. Zhuang & R.P.K.

148. ***Pulvinula convexella*** (P. Karst.) Pfister, Occ. Pap. Farlow Herb. Crypt. Bot. 9: 9. 1976.

On damp soil at top of river bank. Björnelva, near Talvik, Finnmark Fylke, Norway.

Leg.: S. Silvertsen, H. Dissing & R.P.K. 17.viii.1978.
Det: R.P.K.

149. ***Boubovia nicholsonii*** (Massee) Spooner & Y.J. Yao, in Yao & Spooner, Mycol. Res. 100: 194. 1996.

On cow dung. Along Cane River & slope of Good Hope Mt., near Kingston, Jamaica.

This collection was reported (and ascospores illustrated) by R.P. Korf & W.Y. Zhuang, Mycotaxon 20: 607-616. 1984, sub *Pulvinula ovalispora* Boud., a later synonym of Massee's *Humaria nicholsonii.* Molecular work by Brian A. Perry et al. (Mycol. Res. 111: 549-571. 2007) supports placing this species close to the type species of *Boubovia,* rather than with other *Pulvinula* spp.

Leg.: R.P.K., J.R. Dixon, K.P. Dumont, R.W. Erb, D.H. Pfister, D.R. Reynolds, A.Y. Rossman & G.J. Samuels. (CUP-MJ-401) 12.i.1971.
Det.: R.P.K.

150. ***Peziza varia*** (Hedw. : Fr.) Fr., Syst. Mycol. 2(1): 61. 1822.

On sandy soil. Ottawa, Ontario, Canada.

Leg.: P. Snure, M.K. Nobles & M.E. Elliott (66-17) [= DAOM 114926]. 15.vi.1966.
Det.: R.P.K.

Distribution of exsiccati sets

Fourteen sets are issued in 2009 and are deposited in the following herbaria. An asterisk denotes an institution that lacks the first fascicle:

BPI	(Beltsville)	LAH	(Lahore)
BPU	(Budapest)*	MICH	(Ann Arbor)
C	(Copenhagen)*	NY	(New York)
CUP	(Ithaca)	PC	(Paris)
DAOM	(Ottawa)	PR	(Prague)
FH	(Cambridge)*	UC	(Berkeley)
K	(Kew)	UPS	(Uppsala)

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Species of *Hemitrichia (Trichiaceae, Myxomycetes)* in Brazil

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Abstract — In Brazil, eight *Hemitrichia* species are known. Their geographical distribution is herein established and mapped for the four main Brazilian biomes: Amazonian Forest, Cerrado, Caatinga, and Atlantic Forest. *Hemitrichia insignis* is reinstated, and *H. spinifera* is now reported for the first time outside of Colombia.

Key words — Neotropical myxobiota, taxonomy, Cerrado myxomycetes

Introduction

Martin (1948) favored the name *Hyporhamma* Corda over *Hemitrichia* Rostaf., which had been published almost two decades later. However, Martin & Alexopoulos (1969), Farr (1976), Martin et al. (1983), and Lado & Pando (1997) adopted *Hemitrichia*, considering *Hyporhamma* as a nomen confusum. Finally, Lado (2001) recombined the species of *Hemitrichia* into *Hyporhamma*. Although admitting that *Hyporhamma* was nomenclaturally the correct name, Lado et al. (2005) suggested conservation of *Hemitrichia,* based on Article 14.1 of the International Code of Botanical Nomenclature. The proposition was approved and is shown in the last version of the Vienna Code (McNeill et al. 2006: 203).

Hemitrichia presently accommodates 26 species, 13 of them known from the Neotropical Region (Lado 2001, Hernández-Crespo & Lado 2005, Bezerra 2008). Most species were described in the last 50 years, including *H. spinifera*, until now known only from a collection from North Santander, Colombia (Farr 1979). Torrend (1916) described *H. insignis* Torrend and deposited the

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holotype in Herbarium URM. However, the publication only became known recently (Góes Neto & Cavalcanti 2002), so the new species was not accepted by Lado (2001), who did not examine the type material.

Lister (1925) indicated that the type material of *Arcyria decipiens* Berk. collected in 1832 by Charles Darwin in Rio de Janeiro was indeed a typical specimen of *H. clavata,* making this the first record of a *Hemitrichia* species in Brazil.

The first overview of the Brazilian myxomycetes by Torrend (1915) listed 80 species representing 23 genera. Among the *Hemitrichia* species just two (*H. clavata* and *H. serpula*) were mentioned, with *H. serpula* present in the states of Rio de Janeiro, São Paulo, and Bahia. Cavalcanti (1974, 1976, 2002) expanded our knowledge of species of *Hemitrichia* in Brazil, reporting *H. minor* (as *Perichaena minor*), *H. pardina* (as *P. minor* var. *pardina*), and *H. leiocarpa* (as *Arcyria leiocarpa*) from the State of Pernambuco. In this paper, the species of *Hemitrichia* detected in Brazil will be the object of specific commentaries, with special attention to *H. insignis* and *H. spinifera*, the latter recently collected from the Cerrado in Brasília, Distrito Federal.

Material and methods

Hemitrichia specimens from different Brazilian biomes were examined, including new collections from Central and Northeast Brazil. Identifications were determined following Martin & Alexopoulos (1969), Farr (1976, 1979), Martin et al. (1983), and Lado & Pando (1997).

Selected specimens were illustrated, with emphasis placed on the morphology of spores, sporangia, and other taxonomically meaningful structures. Also included are distribution maps of the Brazilian species of *Hemitrichia*. Materials from seven Brazilian herbaria [HUEFS – Herbarium of the Universidade Estadual de Feira de Santana, Feira de Santana, Bahia), IPA – Herbarium Dardano de Andrade Lima, Empresa Pernambucana de Pesquisa Agropecuária, Recife, Pernambuco, JPB – Herbarium of the Universidade Federal da Paraíba, João Pessoa, Paraíba, UFBA – Herbarium of the Universidade Federal da Bahia, Salvador, Bahia, UFP – Herbarium of the Universidade Federal de Pernambuco, Recife, Pernambuco; URM – Herbarium of the Departamento de Micologia, Universidade Federal de Pernambuco, Recife, Pernambuco, and UB [Mycological Collection] – Herbarium of the Universidade de Brasília, Brasília, Distrito Federal] were studied.

Hemitrichia insignis, a taxon proposed by Torrend (1916) is here reinstated; *H. spinifera* is reported for the first time from somewhere other than the type location; and finally comments on the distribution and records of six more species of *Hemitrichia* in Brazil are shown.

Taxonomy and geographical distribution

The goal of this study is to add to our knowledge of the Brazilian myxobiota, and also to highlight the first records of the *Trichiaceae* in Central-Western Brazil.

Over 300 exsiccates of *Hemitrichia* species collected in Brasília were examined, but only the best material is cited. Other materials were collected in eleven different states distributed from the Equatorial Amazonas to south of the Tropic of Capricorn in the State of Santa Catarina.

Among species of *Hemitrichia,* Farr (1976) listed for Brazil only *H. calyculata*, *H. clavata*, and *H. serpula*. However, in 1916 *H. insignis* was described from the State of Bahia and Cavalcanti (1974) reported *Perichaena minor*, and *P. minor* var. *pardina* from the state of Pernambuco, species later included in *Hemitrichia* by Hernández-Crespo & Lado (2005) as *H. minor* and *H. pardina,* respectively. Later, Cavalcanti (1976) also reported *H. leiocarpa* in the same state. Finally, now *H. spinifera* is reported here from Brasília, Distrito Federal, thus completing eight species for the entire country.

Additionally reinstatement of *H. insignis* is proposed based on the study of the type material collected in Bahia (Figure 1) and the original description by Torrend (1916). Also, a detailed description of the Brazilian specimen of *H. spinifera* is given.

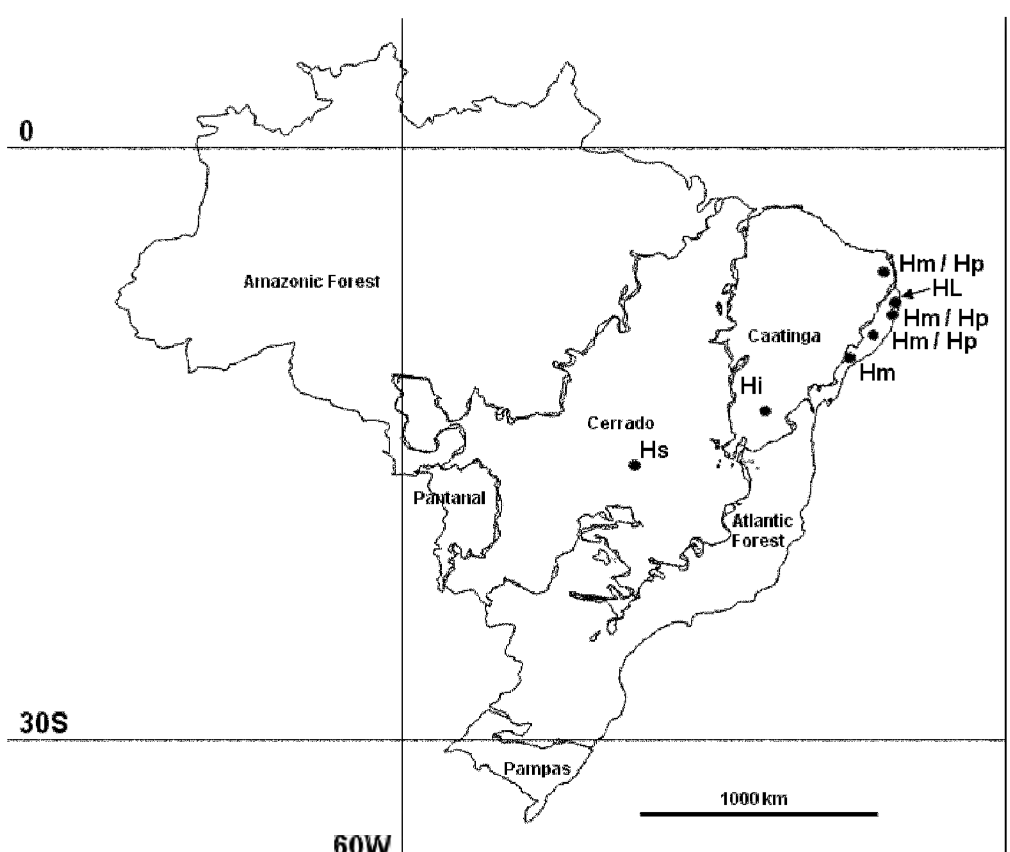

Fig. 1. Distribution of *Hemitrichia insignis* (Hi), *H. leiocarpa* (Hl), *H. minor* (Hm), *H. pardina* (Hp), and *H. spinifera* (Hs) in two Brazilian biomes: Caatinga (semi-arid region) and Cerrado.

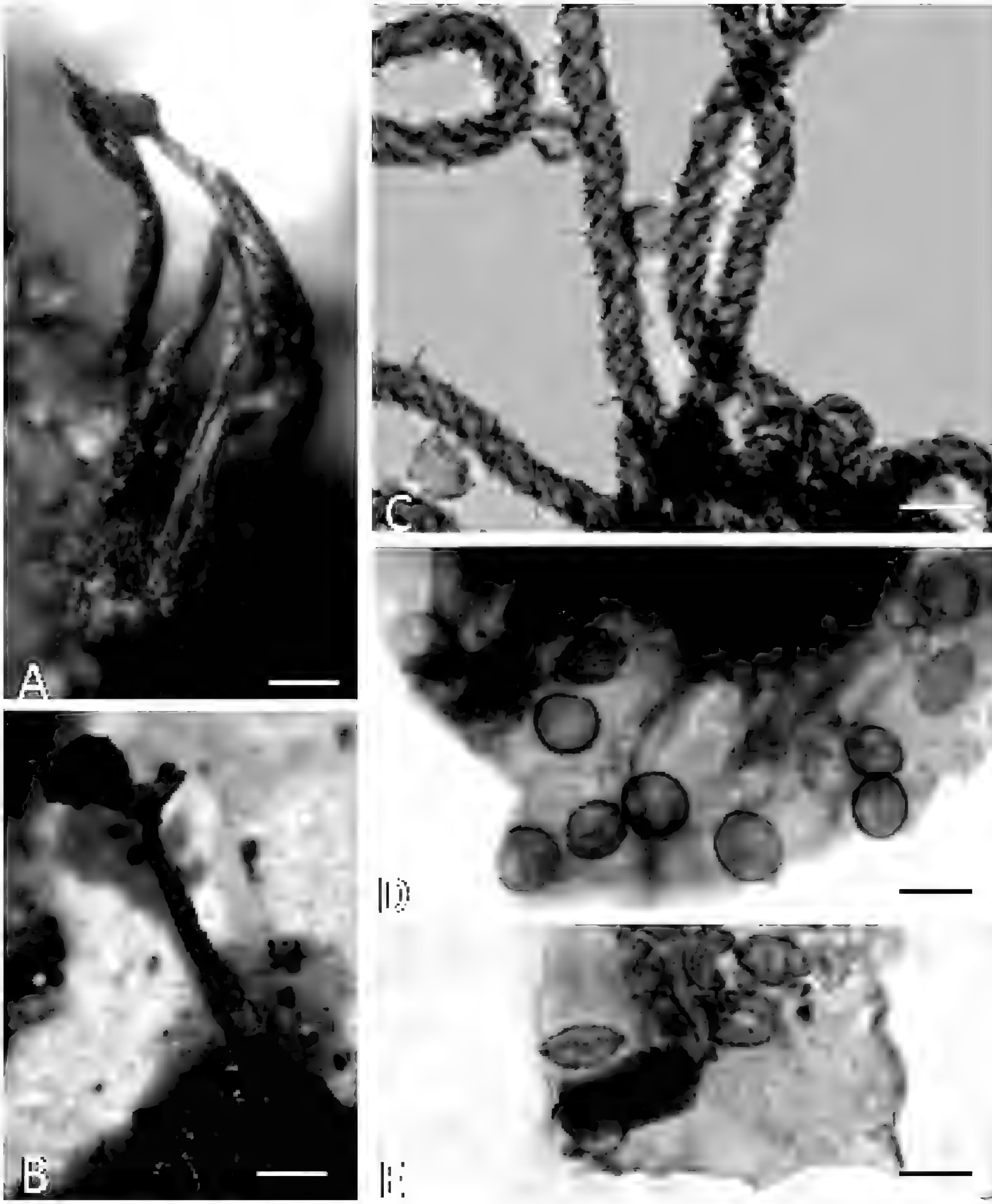

FIG. 2. A–E. *Hemitrichia insignis*. A – Pedicels of the fruiting bodies (bar = 250 µm). B – Sporangium with remnants of the peridium forming a calyculus µm (bar = 250 µm). C – Coiled capillitium with a spinulose surface (bar = 10 µm). D – Spores (bar = 10 µm). E – Surface of the peridium (bar = 10 µm).

Hemitrichia insignis Torrend, Congr. Nac. Geogr. Brasil, Salvador: 489 (1916). FIG. 2
MYCOBANK, MB 512258

The type specimen was described by Torrend (1916) as having *"Plasmodium? Totus fungus-2-3 mm. longus, aurantiaco-ferrugineus; sporangia globosa, longistipitata, 1 mm crassa; peridium leve, nitidum, ad modum caliculi in parte inferiori persistens; stipes 1-2 mm longus, concolor, lucidus, sulcatus; capillitium simplex vel parum ramosum quase*

constaret unico filamento longissimo e dense involuto, 4-5 µm diam. crassum (6-8 µm. cum aculeis); duobus taeniolis spiralibus aculeatis pulchre ornatum; aculei 1-3 µm. longi; sporae aurantiacae, verrucosae, ad marginem incrassatae, 8-10 µm. diam. Hab. Ad fragmenta lígnea, in nemore denso prope. Poções. Januario."

Specimens examined: **BRAZIL. Bahia**: Poções, 1916, *leg Camille Torrend*, URM 574A-10011 (holotype).

Plasmodium not seen. Thalli 2–3 mm long, rusty-orange. Sporangia globose, long-stalked, 1 mm wide. Peridium smooth, shiny, shown as calyculus at the lower portion. Stipes 1–2 mm long, concolorous, shiny, sulcate. Capillitium simple or seldom branched, mostly consisting of one densely involute and long filament, 4–5 µm diam., 6–8 µm when including the spines; forming two spiral spiny ropes beautifully ornamented; spines 1–3 µm long. Spores orange, verrucose, thick walled, 8–10 µm diam.

Comment: Torrend (1916) considered the type specimen of *H. insignis* macroscopically similar to *H. vesparium* [=*Metatrichia vesparium*]; however, he emphasized that the microscopic characters were different, e.g.: his new species showed a fragile peridium with irregular dehiscence contrasting with the leathery peridium and circumcised dehiscence present in *M. vesparium*. The type material in Herbarium URM [URM 574A-10011] still contains sporangia with some damage but enough to confirm the essential characteristics described by Torrend (1916), thus justifying this proposition for the reinstatement of *H. insignis*.

Hemitrichia spinifera M.L. Farr, Nova Hedwigia 31(1–3): 110 (1979). Figs. 1, 3

≡ *Hyporhamma spiniferum* (M.L. Farr) Lado [as '*spinifera*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 48 (2001).

Specimens examined: **BRASIL. Distrito Federal**: Brasília, Jardim Botânico, Córrego Cabeça de Veado, 27 Aug 2001, *leg M. Sanchez 4031* (UB Mycol Col. 18558); idem, 27 Aug 2001, *leg A.C.C. Bezerra 432* (UB Mycol Col. 18560); idem, 27 Aug 2001, *leg A. C. C. Bezerra* 433 (UB Mycol Col. 18561); idem, 27 Aug 2001, *leg A. C. C. Bezerra* 434 (UB Mycol Col. 18562). **COLOMBIA. Santander:** North of Santander, about 3,300 m alt., 21 Aug 1976, *leg K. P., Dumont, MA. Sherwood, and L. F. Velasquez, BPI 838725,* U.S. National Fungus Collections, USDA. BPI 838725.

The four specimens collected in Brasília, Distrito Federal (Figure 1), were all identified as *H. spinifera* when compared with the type material collected at the type location in Colombia, establishing this as a second record of the species worldwide after the original description by Farr (1979).

Hemitrichia leiocarpa (Cooke) Lister, Monogr. Mycetozoa: 177 (1894).

≡ *Hemiarcyria leiocarpa* Cooke, Annals Lyceum nat. Hist. N.Y. 11(12): 405 (1877).

≡ *Arcyria leiocarpa* (Cooke) Massee, Monogr. Myxogastr. (London): 167 (1892).

≡ *Hyporhamma leiocarpum* (Cooke) Lado [as '*leiocarpa*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) **16**: 47 (2001).

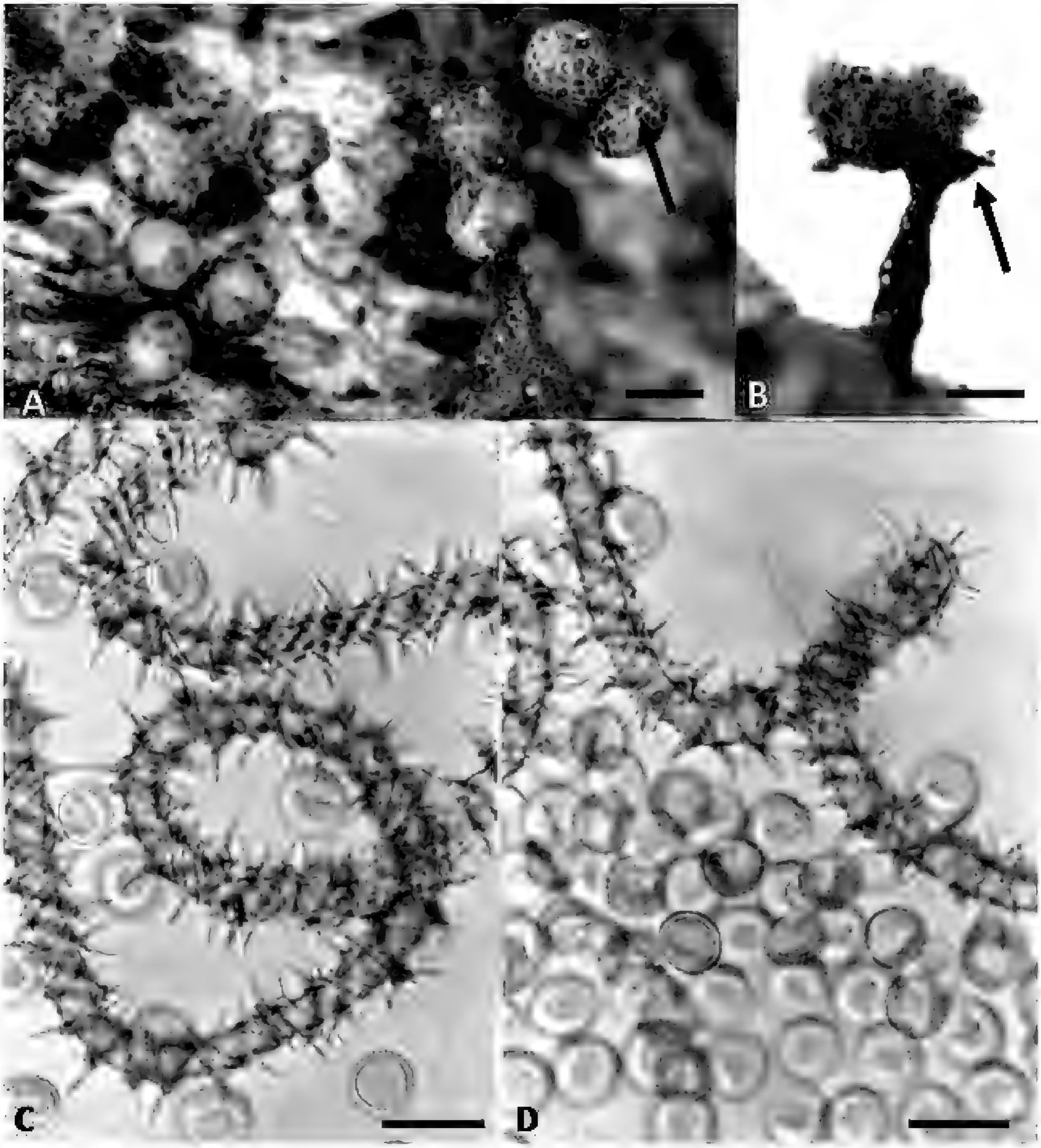

Fig. 3. A–D. *Hemitricha spinifera*. A and B – Sporangia (bar = 0.5 mm); C – Spinulose filaments of the capillitium (bar = 10 μm); D – Spores and capillitium (bar = 10 μm).

Hemitrichia leiocarpa is known in Brazil only from Pernambuco (Fig. 1) through a collection (BPI 833075) from a decaying trunk of *Cocos nucifera* L. (Cavalcanti 1974).

Hemitrichia minor G. Lister, J. Bot. 49: 62 (1911).

≡ *Perichaena minor* (G. Lister) Hagelst., Mycologia 35(1): 130 (1943).

≡ *Hyporhamma minus* (G. Lister) Lado [as '*minor*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 48 (2001).

The first specimen of *H. minor* from Brazil was collected in the state of Pernambuco (Cavalcanti 1974), then identified as *Perichaena minor*. Later,

also in Pernambuco, Cavalcanti & Dias-Filha (1985), studying the *Trichiales* on bryophytes at the Herbarium UPE, found *H. minor* on trunks of living trees belonging to the *Fabaceae*, *Moraceae*, and *Anacardiaceae*. An additional sample was detected on the decaying spathe of an unidentified member of the *Arecaceae*. Recently, a specimen was found on herbivorous manure in a savanna region of the state of Sergipe in the Brazilian Northeast (Bezerra et al. 2008). Now, *H. minor* is reported for the first time from a natural reserve of the Atlantic Forest in the state of Rio Grande do Norte, on leaves of *Cecropia adenopus* Mart. ex Miq. (*Cecropiaceae*), and its distribution is shown in FIGURE 1. *Hemitrichia minor* was also found on a cactaceous substrate (*Copiapoa* sp.) in Chile by Lado et al. (2007), who together with Farr (1976) noted that the species is common in arid regions of North America, but rare in South America. However, the specimens known in Brazil are mostly from cultures yielding few sporangia in wet chambers using substrates collected in humid habitats (FIG. 1).

Hemitrichia pardina (Minakata) Ing, Myxomycetes Britain and Ireland: 132 (1999).

≡ *Hemitrichia minor* var. *pardina* Minakata, in Lister, Trans. Br. mycol. Soc. 5: 82 (1915).

≡ *Perichaena minor* var. *pardina* (Minakata) Hagelst., Mycologia 35(1): 131 (1943).

≡ *Hyporhamma pardinum* (Minakata) Lado [as '*pardina*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 48 (2001).

Hemitrichia pardina is seldom found but has been known for more than three decades in Pernambuco, Northeast Brazil, when it was treated as *Perichaena minor* var. *pardina* (Cavalcanti 1974). Recently, specimens were collected in the neighboring states of Alagoas and Rio Grande do Norte (Cavalcanti et al. 2005) (FIGURE 1).

Hemitrichia clavata (Pers.) Rostaf, in Fuckel,
Jahrb. Nassauischen Vereins Naturk. 27–28: 75 (1873).

≡ *Trichia clavata* Pers., Neues Mag. Bot. 1: 90 (1794).

≡ *Hemiarcyria clavata* (Pers.) Rostaf., Śluzowce monogr. (Paryz): 264 (1875).

≡ *Arcyria clavata* (Pers.) Massee, Monogr. Myxogastr. (London): 165 (1892).

≡ *Hyporhamma clavatum* (Pers.) Lado [as '*clavata*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 47 (2001).

Hemitrichia clavata and *H. calyculata* are morphologically similar, but Lado & Pando (1997) separated the two taxa as follows: *H. clavata* would show darker sporangial pedicels and larger spores than *H. calyculata*. Martin & Alexopoulos (1969) and Farr (1976) suggested that the materials from the Tropics should be re-examined because apparently many tropical collections of *H. clavata* have proven to be *H. calyculata*. Hence, two specimens from Recife, state of Pernambuco, previously identified as *H. clavata* (Mariz & Cavalcanti 1970) were re-examined and shown to belong in *H. calyculata*. However, in Brazil *H. clavata* is not common although it is known in warmer areas such as the

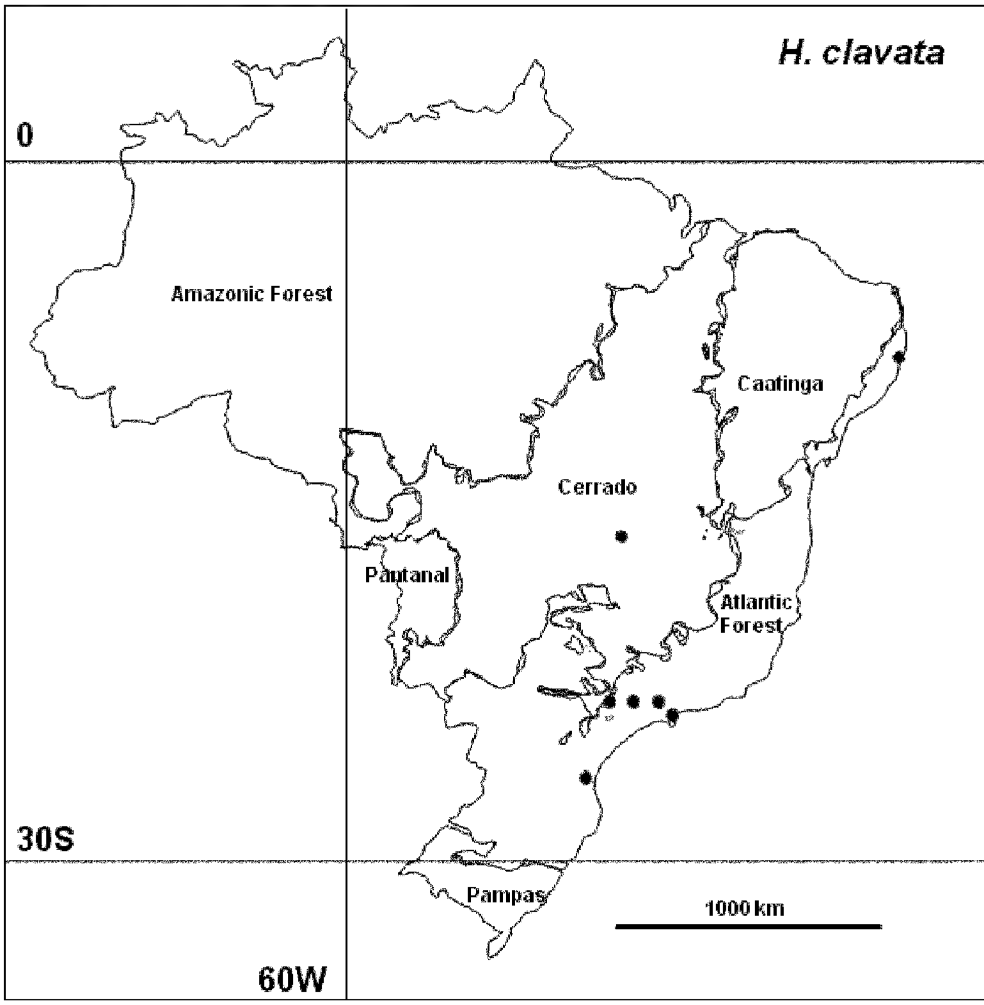

FIG. 4. Distribution of *Hemitrichia clavata*. in three of the main Brazilian Biomes: Atlantic Forest, Caatinga and Cerrado.

Brazilian Northeast (Cavalcanti 2002) and the southeastern state of São Paulo (Hochgesand & Gottsberger 1996, Maimoni-Rodella 2002). It is also known from the cooler areas of South Brazil. Bresadola (1896) first recorded the species in Brazil based on Alfredo Möller´s collections in Blumenau, State of Santa Catarina, as *Hemiarcyria clavata* (=*Hemitrichia clavata*). For the first time *H. clavata* is reported here from Central Brazil through a collection in gallery forest located at Brasilia, Distrito Federal, as seen in FIGURE 4.

Hemitrichia calyculata (Speg.) M.L. Farr, Mycologia 66: 887 (1974).

≡ *Hemiarcyria calyculata* Speg., Anal. Soc. cient. argent. 10: 152 (1880).

≡ *Hemitrichia clavata* var. *calyculata* (Speg.) Y. Yamam., in Yamamoto et al., Crypt. Flora .Pakistan (Tokyo) 2: 28 (1993).

≡ *Hyporhamma calyculatum* (Speg.) Lado [as '*calyculata*'], Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 47 (2001).

= *Hemiarcyria stipitata* Massee, J. Roy. Microscop. Soc. 1889(1): 354 (1889).

≡ *Arcyria stipitata* (Massee) Massee, Monogr. Myxogastr. (London): 163 (1892).

≡ *Hemitrichia clavata* var. *stipitata* (Massee) Torrend, Brotéria 7: 50 (1908).

≡ *Hemitrichia stipitata* (Massee) T. Macbr., N. Amer. Slime-Moulds (New York): 207 (1899).

The comprehensive material studied shows that *H. calyculata* occurs in Brazil in different types of habitats varying from equatorial regions in densely shadowed Atlantic or Amazonian forest, in the Cerrado, or in the semi-arid Northeastern Caatinga, in addition to being found on debris or the bark of trees in areas with degraded vegetation, in urban sites, and in sugar cane plantations (Cavalcanti 1996, Cavalcanti et al. 2005), distributed as in FIGURE 4. A collection of *Hemitrichia clavata* var. *calyculata* by Sannomiya in 1939 from São Paulo, exsiccate TNS-M-R: 1514, was given by Goro Hashimoto to Emperor Showa, and remains deposited in the Herbarium of the National Science Museum in Tokyo (Yamamoto et al. 2000).

The first record of *H. calyculata*, [identified as *H. stipitata* in the Brazilian Northeast was from the state of Pernambuco, later detected also in the state of Alagoas (Cavalcanti et al. 1985) growing on sugarcane debris, and in fragments of the Atlantic Forest (Cavalcanti et al., 2006). The same species was found on palm trees, and second growth forests in the states of Ceará and Piauí (Alves & Cavalcanti 1996; Cavalcanti & Putzke 1998; Mobin & Cavalcanti 2000, Mobin & Cavalcanti 2001, Cavalcanti 2002). Other records include coastal areas, and parts of the Biome Caatinga in Bahia; sugarcane plantations in the states of

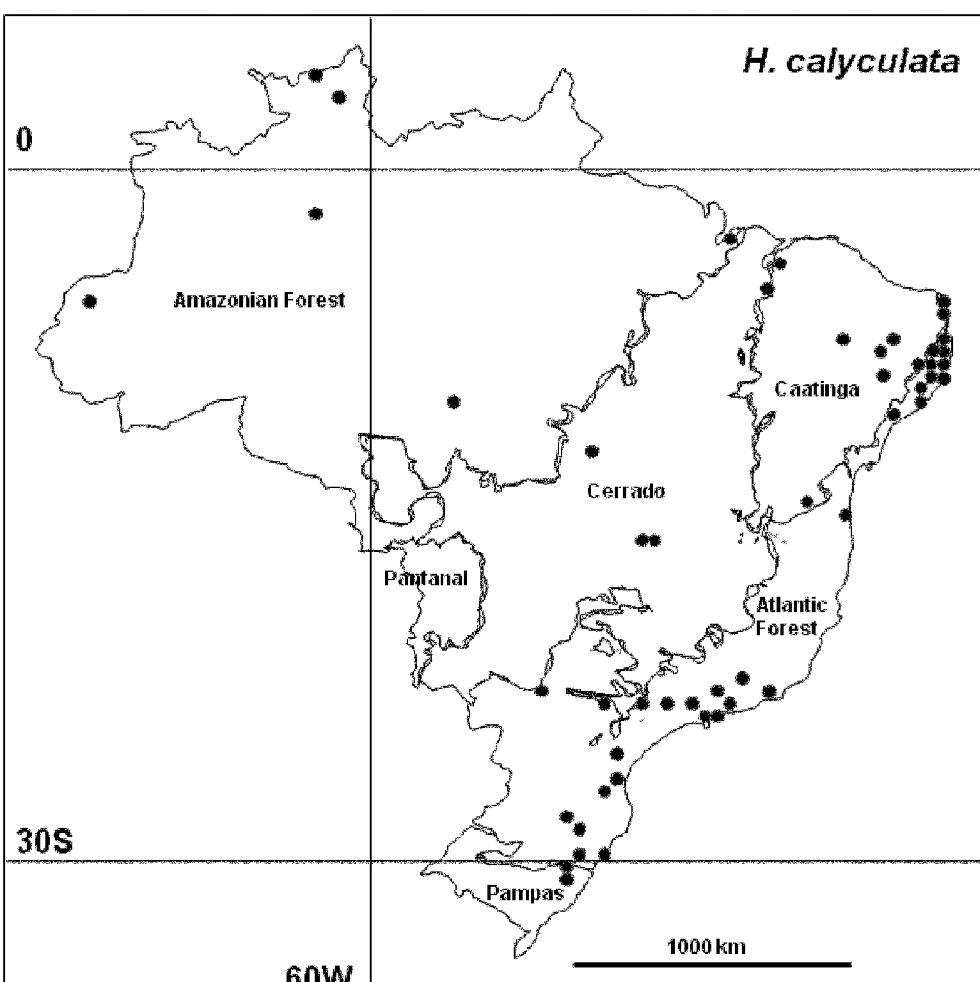

FIG. 5. Distribution of *Hemitrichia calyculata* in the four main Brazilian Biomes: Amazonian Forest, Atlantic Forest, Caatinga and Cerrado.

Pernambuco and Paraíba, and in urban areas of Rio Grande do Norte, Paraíba and Pernambuco (Farr 1960, Gottsberger 1968, Cavalcanti & Marinho 1985, Santos & Cavalcanti 1988, Alves & Cavalcanti 1996, Cavalcanti 1996, 2002, Bezerra et al. 2007). In North Brazil, *H. calyculata* was found in the states of Amazonas and Roraima (Farr 1985, Cavalcanti et al. 1999). Finally, the species is known from South Brazil in the states of Paraná, Santa Catarina and Rio Grande do Sul (Guerrero 1985, Gottsberger et al. 1992, Cavalcanti & Fortes 1994). Now for the first time *H. calyculata* is reported here from Brasília in Central Brazil, based on collections of 2000 and 2002. The distribution of *H. calyculata* is shown in Figure 5.

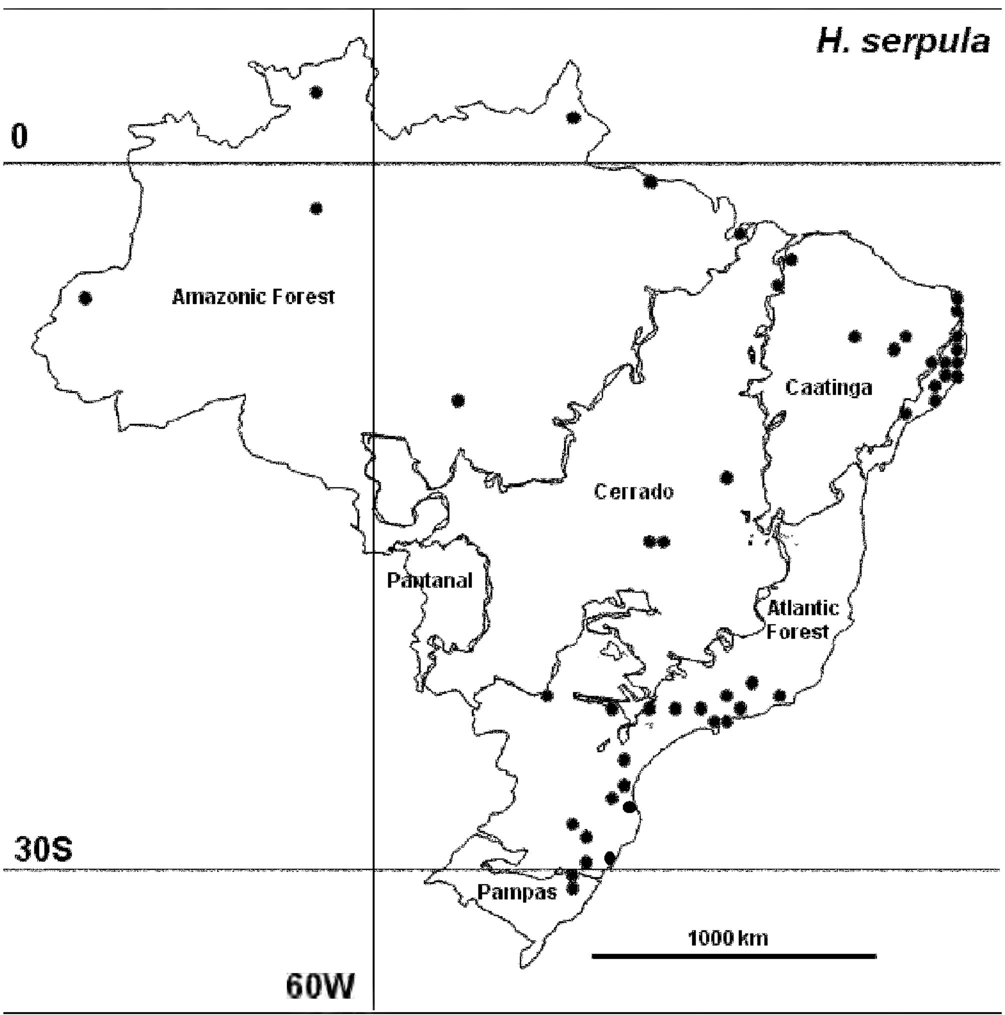

Fig. 6. Distribution of *Hemitrichia serpula* in the four main Brazilian biomes: Amazonian Forest, Atlantic Forest, Caatinga and Cerrado.

Hemitrichia serpula (Scop.) Rostaf. ex Lister, Monogr. Mycetozoa: 179 (1894).

Mucor serpula Scop., Fl. carniol., Edn 2 (Wien) 2: 493 (1772).
Trichia serpula (Scop.) Pers., Tent. disp. meth. Fung.: 10 (1797).
Hemiarcyria serpula (Scop.) Rostaf., Śluzowce monogr. (Paryz): 266 (1875).
Arcyria serpula (Scop.) Massee, Monogr. Myxogastr. (London): 164 (1892).
Hyporhamma serpula (Scop.) Lado, Cuadernos de Trabajo de Flora Micológica Ibérica (Madrid) 16: 48 (2001).

Hemitrichia serpula is the most common species in the genus occurring in Brazil (Cavalcanti 2002, Maimoni-Rodella 2002, Putzke 2002). The first record of the species in South Brazil (Jahn 1902) was based on collections from Blumenau, state of Santa Catarina. *Hemitrichia serpula* was found again in Santa Catarina, Paraná, and in Rio Grande do Sul (Rodrigues & Guerrero 1990, Gottsberger et al. 1992, Cavalcanti & Fortes 1994). Jahn (1904) detected *H. serpula* from the state of Amazonas, where the species is presently known in the states of Amapá, Amazonas, Pará, and Roraima (Cavalcanti 2002; Cavalcanti et al. 1999). In the Southeastern region of Brazil the first record came from the state of São Paulo (Höhnel 1907). New records for the region came from collections in the states of São Paulo and Rio de Janeiro (Torrend 1915, Maimoni-Rodella & Gottsberger 1980, Rodrigues 1985). In the Brazilian Northeast *H. serpula* has been known since the early twentieth century (Torrend 1915) at different localities in the state of Bahia; and later in the states of Alagoas, Ceará, Paraiba, Pernambuco, Piauí, Rio Grande do Norte and Sergipe (Batista 1949; Farr 1960; Mariz 1968; Cavalcanti 1976; Cavalcanti & Marinho 1985; Alves & Cavalcanti 1996; Mobin 1997; Cavalcanti 2002; Bezerra et al. 2007, Bezerra et al. 2008). In Central Brazil *H. serpula* is now reported in Mato Grosso based on collection by J.R. Weir, in 1923 (BPI 839124), and also from Cerrado and gallery forest in Brasília, Distrito Federal. The distribution of the species in Brazil is shown in Figure 6.

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Epigeous macrofungi of the Parque de Natureza de Noudar in Alentejo (Portugal)

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Abstract – This inventory represents the first list of the epigeous macrofungi collected in Parque de Natureza de Noudar (Barrancos, Alentejo, Portugal). Throughout 3 years 162 taxa were registered, from which 8 are new species for Portugal and 77 for Alentejo. Some of them are considered rare species whereas others have been suggested for conservation status. Full-length weblist on URL: http://home.dbio.uevora.pt/~css/

Keywords – fungi, holm oak, mediterranean ecosystem, Iberian Peninsula, sporocarps

Introduction

The cork-oak (*Quercus suber* L.) and holm-oak (*Quercus rotundifolia* Lam. = *Quercus ilex* subsp. *ballota* (Desf.) Samp.) stands are the most frequent agroforestry systems in Alentejo (Portugal). In this region 35% of the total forest area is occupied by holm-oak stands. These ecosystems are known for their biodiversity, namely their richness in macrofungal species (DGF 2001). This study was conducted in the Parque de Natureza de Noudar – Barrancos (38° 08' N and 6° 59' W), Alentejo – where the landscape is dominated by holm-oak stands with different shrub or herbaceous composition and cover. The understory consists of mixed sclerophyllous shrubs, mainly *Cistus* spp., *Lavandula* spp., *Genista* spp., *Myrtus communis* L., *Pistacia lentiscus* L., and natural pasture of annual herbaceous (mostly *Asteraceae*, *Poaceae* and *Fabaceae*). Furthermore, this area shelters a number of rich floral communities, with a long natural history of adaptation to the Mediterranean climate and human activities.

With a total area of 994.5 ha, the Parque de Natureza de Noudar is delimited by the Ardila river and the Múrtega stream. Inserted in a classified area of the

Rede Natura 2000, it forms an ecological group with other protected areas in Spain.

The climate is Mediterranean, with rainy mild winters and hot dry summers. Mean annual rainfall is 525.6 mm and mean annual air temperature 15.8 °C, with a dry period from May to September (Mendes et al. 1991). The soils are predominantly Luvisols and Leptosols.

Materials and methods

All specimens were collected from November 2004 to April 2007 in 43 plots scattered throughout the different biotopes with a total area of 1.13 ha. Collected specimens were preserved and deposited in the Évora University Herbarium (UEVH- FUNGI).

Plant nomenclature follows Franco (1971). The macrofungal catalogue is arranged alphabetically according to order and genus. Taxonomy and nomenclature follows Kirk et al. (2001) and Kirk (2004–08). Current species distribution area was consulted in: Calonge (1998), CMUL (2002), Hernández-Crespo (2006), Pinho-Almeida & Baptista-Ferreira (1996, 2005) and GBIF (2008). New occurrences for Alentejo are marked with (*) and for Portugal (**).

Results

Over a 3-year period, 68 genera comprising 162 macrofungi species were collected. Of these, 77 represent new records to the Alentejo region, namely: *Agaricus xanthodermus* var. *lepiotoides* Maire, *Agrocybe molesta* (Lasch) Singer, *Amanita ceciliae* (Berk. & Broome) Bas, *Bovista delicata* Berk. & M.A. Curtis, *Bovista dermoxantha* (Vittad.) De Toni, *Calvatia excipuliformis* (Scop.) Perdeck, *Chalciporus piperatus* (Bull.) Bataille, *Clavulina cinerea* (Bull.) J. Schröt., *Clavulina rugosa* (Bull.) J. Schröt., *Clitocybe font-queri* R. Heim, *Clitocybe obsoleta* (Batsch) Quél., *Coprinus alopecia* Lasch, *Cortinarius bulliardii* (Pers.) Fr., *Cystoderma amianthinum* (Scop.) Fayod, *Entoloma cistophilum* Trimbach, *Entoloma hebes* (Romagn.) Trimbach, *Entoloma papillatum* (Bres.) Dennis, *Entoloma serrulatum* (Pers.) Hesler, *Entoloma undatum* (Fr.) M.M. Moser, *Galerina vittiformis* (Fr.) Earle, *Geastrum elegans* Vittad., *Hebeloma cistophilum* Maire, *Helvella leucomelaena* (Pers.) Nannf., *Hydropus floccipes* (Fr.) Singer, *Hygrocybe miniata* (Fr.) P. Kumm., *Hygrophorus arbustivus* Fr., *Inocybe asterospora* Quél., *Inocybe calospora* Quél., *Inocybe cervicolor* (Pers.) Quél., *Inocybe flocculosa* (Berk.) Sacc., *Inocybe fuscidula* Velen. var. *fuscidula*, *Inocybe godeyi* Gillet, *Inocybe napipes* J.E. Lange, *Ileodictyon gracile* Berk., *Lactarius camphoratus* (Bull.) Fr., *Lactarius cistophilus* Bon & Trimbach, *Leccinum corsicum* (Rolland) Singer, *Lepiota clypeolaria* (Bull.) P. Kumm.,

Lepiota griseovirens Maire, *Lepiota oreadiformis* Velen., *Lepiota pseudolilacea* Huijsman, *Lepiota subgracilis* Wasser, *Lepista sordida* (Fr.) Singer, *Lycoperdon lividum* Pers., *Lycoperdon nigrescens* Wahlenb., *Marasmius bulliardii* Quél., *Melanoleuca grammopodia* (Bull.) Murrill, *Mycena abramsii* (Murrill) Murrill, *Mycena aetites* (Fr.) Quél., *Mycena filopes* (Bull.) P. Kumm., *Mycena galopus* var. *nigra* Rea, *Mycena pura* (Pers.) P. Kumm., *Otidea alutacea* (Pers.) Massee, *Panaeolina foenisecii* (Pers.) Maire, *Panaeolus fimicola* (Pers.) Quél., *Parasola auricoma* (Pat.) Redhead et al., *Peziza arvernensis* Boud., *Peziza domiciliana* Cooke, *Peziza succosa* Berk., *Peziza varia* (Hedw.) Fr., *Phaeomarasmius erinaceus* (Pers.) Scherff. ex Romagn., *Pholiota highlandensis* (Peck) A.H. Sm. & Hesler, *Pluteus phlebophorus* (Ditmar) P. Kumm., *Polyporus alveolaris* (DC.) Bondartsev & Singer, *Polyporus meridionalis* (A. David) H. Jahn, *Psathyrella conopilus* (Fr.) A. Pearson & Dennis, *Psathyrella panaeoloides* (Maire) M.M. Moser, *Psathyrella spadiceogrisea* (Schaeff.) Maire, *Rhodocybe nitellina* (Fr.) Singer, *Rickenella fibula* (Bull.) Raithelh., *Russula pseudo-olivascens* Kärcher, *Russula purpurata* Crawshay, *Tarzetta catinus* (Holmsk.) Korf & J.K. Rogers, *Thelephora caryophyllea* (Schaeff.) Pers., *Tremella foliacea* Pers., *Tricholoma saponaceum* (Fr.) P. Kumm. var. *saponaceum* and *Tricholoma squarrulosum* Bres.

Also, within the collected species 8 are new citations to Portugal, specifically: *Clitocybe squamulosoides* var. *meridionalis* Bon, *Entoloma occultopigmentatum* Noordel. & Arnolds, *Hygrophorus eburneus* var. *cossus* (Sowerby) Quél., *Leucoagaricus melanotrichus* (Malençon & Bertault) Trimbach var. *melanotrichus*, *Mycena erubescens* Höhn., *Mycena flavescens* Velen., *Mycena rubromarginata* (Fr.) P. Kumm. var. *rubromarginata* and *Pluteus podospileus* Sacc. & Cub.

Furthermore 6 of the identified species are considered rare within the Iberian Peninsula: *Agaricus porphyrizon* P.D. Orton, *Ileodictyon gracile*, *Lactarius camphoratus*, *Lepiota oreadiformis*, *Leucoagaricus melanotrichus* var. *melanotrichus* and *Phaeomarasmius erinaceus*.

Additionally, *Amanita caesarea* (Scop.) Pers., *Amanita verna* (Bull.) Lam., *Cortinarius orellanus* Fr., *Gyroporus castaneus* (Bull.) Quél. and *Hygrocybe conica* (Scop.) P. Kumm. var. *conica*, also found in the Parque de Natureza de Noudar, have been referred by Prof. Dr. Francisco Calonge as threatened (SMM 2008), thus their conservation status in the Iberian Peninsula needs urgent assessment and legislation.

Conclusions

The high number of new references is undoubtedly due to the scarcity of mycological surveys in Southern Portugal, particularly in Alentejo. In fact, some of these new references correspond to widespread species in the Iberian

Peninsula. On the other hand, some rare or vulnerable species occurred as was expected for this typical Mediterranean ecosystem known by its biodiversity.

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Tomentellopsis pulchella sp. nov. from St. Vitale Pine Forest (Ravenna, Italy)

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Abstract—A new thelephoroid species, *Tomentellopsis pulchella,* is described from Italy. It is a distinct taxon with yellow to orange hymenium and with small globose spores. According to the rDNA ITS sequences the closest species are *T. bresadolana* and an undescribed taxon found in Finland. So far *T. pulchella* is found only in St. Vitale (Italy) pine-forest.

Key words—taxonomy, thelephoroid fungi, *Thelephorales*, ectomycorrhiza

Introduction

The genus *Tomentellopsis* belongs to the fungal order *Thelephorales* (*Homobasidiomycetes*) and all known species of the genus form resupinate basidiomata. Kõljalg (1996) recognized in this genus only three species, viz. *Tomentellopsis echinospora*, *T. pusilla,* and *T. zygodesmoides*. Based on morphology and molecular features we accept here also *T. bresadolana* and *T. submollis,* following in this way the concept of the genus proposed by Hjortstam (1974). The basidiomata of *Tomentellopsis* are mostly found in the upper layer of the soil attached to the underside of dead wood, leaves, and other debris. It is likely that all species are ectomycorrhiza (EcM) formers with worldwide distribution. The well-known pink-type EcM was lately linked via rDNA ITS sequences to *T. submollis* (Kõljalg et al 2002). Soon other studies followed, which showed that *T. submollis*, *T. zygodesmoides* and *T. echinospora* are forming EcM on different host trees (Burke et al. 2005, Rosling et al. 2003, Saari et al. 2005, Tedersoo et al. 2006, Walker et al. 2005). We have no proof that the new species described in this paper forms EcM, but based on previous studies it is logical to deduce this.

Mycobiota of the St. Vitale pine-forest (Ravenna, Italy) is comparatively well studied with many rare species, including some new to science (e.g. Bernicchia 2005, Hausknecht & Zuccherelli 1999, Noordeloos & Hausknecht 2002). In 2000 and 2001 several yellow to orange basidiomata of an unknown *Tomentellopsis* were collected on small branches, twigs and litter, particularly of *Crataegus* and *Quercus*. Based on morphology and molecular analyses we describe these specimens as a new species, *T. pulchella*.

Material and methods

Light microscopy

For light microscopic studies, samples were mounted in 3% potassium hydroxide (KOH) and Melzer's solution. Microphotos were made using an AxioCam MRc digital camera attached to a Carl Zeiss Axioskop 2 microscope and grabbed into computer with AxioVision 3.0 software.

Molecular and phylogenetic analyses

Pieces of hymenium from sporocarps were used for the DNA extraction. The primer pairs ITS1-ITS4 or ITS1F-ITS4B (White et al. 1990, Gardes & Bruns 1993) were used for the amplification and sequencing of ITS regions. For comments on these two primer pairs and for full descriptions of molecular methods see Kõljalg et al. (2002) and Tedersoo et al. (2003). For this study four new sequences were obtained and they were deposited in EMBL as well as in UNITE (Kõljalg et al. 2005). The UNITE accession is linked to a colour picture of the basidioma. The additional 38 ITS sequences used in this study were received from EMBL and GenBank databases.

The ITS sequences were assembled and aligned using Sequencher 4.6 (GeneCodes Corp.). Alignment was checked and improved manually in PAUP* 4.0b10 (Swofford 2003). The final dataset included 44 ITS sequences – 22 sequences originating from ectomycorrhizas and 22 sequences from sporocarps. After alignment the database included 636 characters but forty extreme 3' positions were excluded from all analyses because they were incomplete for many taxa.

Phylogenetic analyses were performed using programs PAUP* 4.0b10 and MrBayes 3.1.2 (Huelsenbeck & Ronquist 2001), all characters were treated as unordered, equally weighted and gaps were treated as missing data. Maximum parsimony (MP) analyses were conducted using 1000 heuristic searches with random taxon addition sequences, TBR branch swapping, maxtrees set to 10000, and restrictions to save 100 trees per replicate. Followed by additional swapping of the resulting trees. A bootstrap analysis was performed with 1000 replicates, each with 10 random taxon addition sequences.

A distance neighbour-joining analysis was conducted with substitution model TrNef+I+G selected by Modeltest 3.7 (Posada & Crandall 1998) under Akaike (AIK) information criterion.

Bayesian inference of phylogeny was performed with MrBayes 3.1.2 with the SYM+I+G substitution model chosen through AIK information criterion in MrModeltest 2.2 (Nylander 2004). The Markov chain Monte Carlo (MCMC) was run with 2000000 generations, and with default values of other prior settings. According to the specified generations the first 200000 generations without reaching a stable likelihood score were discarded, leaving 36002 trees for computing the consensus trees and posterior probability (PP) values.

The difference between samples was determined using the PAUP* command Pairwise Base Difference and are shown as percentages.

Species description

Tomentellopsis pulchella Kõljalg & Bernicchia, **sp. nov.** FIGS. 1–3

MYCOBANK MB 511675

Carposomata effusa, cohaesa deinde pellicularis, subtilia, separabilia. Hymenophorum leve, arachnoideum, gilvum, flavente in maturitate, ochraceum cum exsiccatione; margine leviter fimbriato, rhizomorphae adsunt, filii mycelii aliquando marginibus adsunt. Hyphae subiculi septatae, fibulis vacuae, tenuiter tunicateae vel leviter crassitunicatae, hyalinae aut flavo-brunneae, 4.2–5.5 μm latae. Hyphae subhymeniales hyalinae, leves, 2.8–4.2 μm latae, septatae, ramosae, tenuiter tunicatae. Cystidia desunt. Basidia hyalina, sinuosa, flexuosa, 28–30(–35) × 5–5.5 μm, 4-sterigmatibus. Basidiosporae hyalinae in 3% solutione KOH, globosae vel subglobosae, echinulatae, 4.5–5.5 μm.

HOLOTYPUS: *Italy, Ravenna, Pineta S. Vitale, 15.XI. 2000, A. Bernicchia (7345) in herbarium HUBO concervatus est.*

ETYMOLOGY: the name derives from the shining colour of the fresh material.

ITS rDNA sequence accession numbers—EMBL AJ410780; UNITE UDB000204.

BASIDIOCARP annual, resupinate, separable or rarely adherent to the substratum, pelliculose to arachnoid, continuous. HYMENOPHORE smooth, yellow to orange coloured when fresh, with brick red shades in mature specimens, dull yellow when dry, concolorous with or turning paler than subiculum. STERILE MARGIN smooth to byssoid, yellow, becoming orange coloured in mature specimens. RHIZOMORPHAE not seen, but very thin, slender and yellow mycelial cords sometimes present.

SUBICULAR HYPHAE hyaline or yellowish to very pale brown in 3% KOH, thin-walled to very slightly thick-walled, simple-septate, cross-shaped branching common, 4.2–5.5 μm diam, encrusted with yellow crystals. SUBHYMENIAL HYPHAE hyaline in 3% KOH, simple-septate, thin-walled, smooth, 2.8–4.2 μm diam. CYSTIDIA not seen. CYSTIDIOLES obtuse, flexuose. BASIDIA hyaline, simple-septate at base, 28–30(–35) × 5–5.5 μm, sometimes with numerous

oil drops, 4 sterigmata, slender and 3–4 µm long. Basidiospores hyaline in 3% KOH, yellowish in mass, globose to subglobose, echinulate, 4.5–5.5 µm including spines. Encrustations appear yellow to reddish and better seen in mature specimens, but rapidly dissolve in KOH. Chlamydospores not seen.

Distribution and ecology. So far *T. pulchella* is found only in St. Vitale pine-forest. It lies along the Adriatic coast, about 10–15 km North of Ravenna, and covers at present ca 20 km^2, but coverage has been considerably decreased. This pinewood is a heterogeneous forest, the result of a balance between natural environmental conditions and anthropic influence over many centuries. At the present we can distinguish a xerophilous forest (mainly consisting of *Quercus robur, Q. pubescens, Fraxinus ornus, Pyrus communis, Cornus mas, Acer campestre, Pinus pinea, P. pinaster* and some species of shrubs) on the top of ancient dunes, and the hygrophilous forest established in the depressions between the dunes (with *Populus alba, Fraxinus oxycarpa, Ulmus campestris, Salix alba, S. caprea, Cornus sanguinea* and *Crataegus monogyna*). If *T. pulchella* is an EcM forming fungus then the potential hosts are *Quercus* and / or *Pinus*.

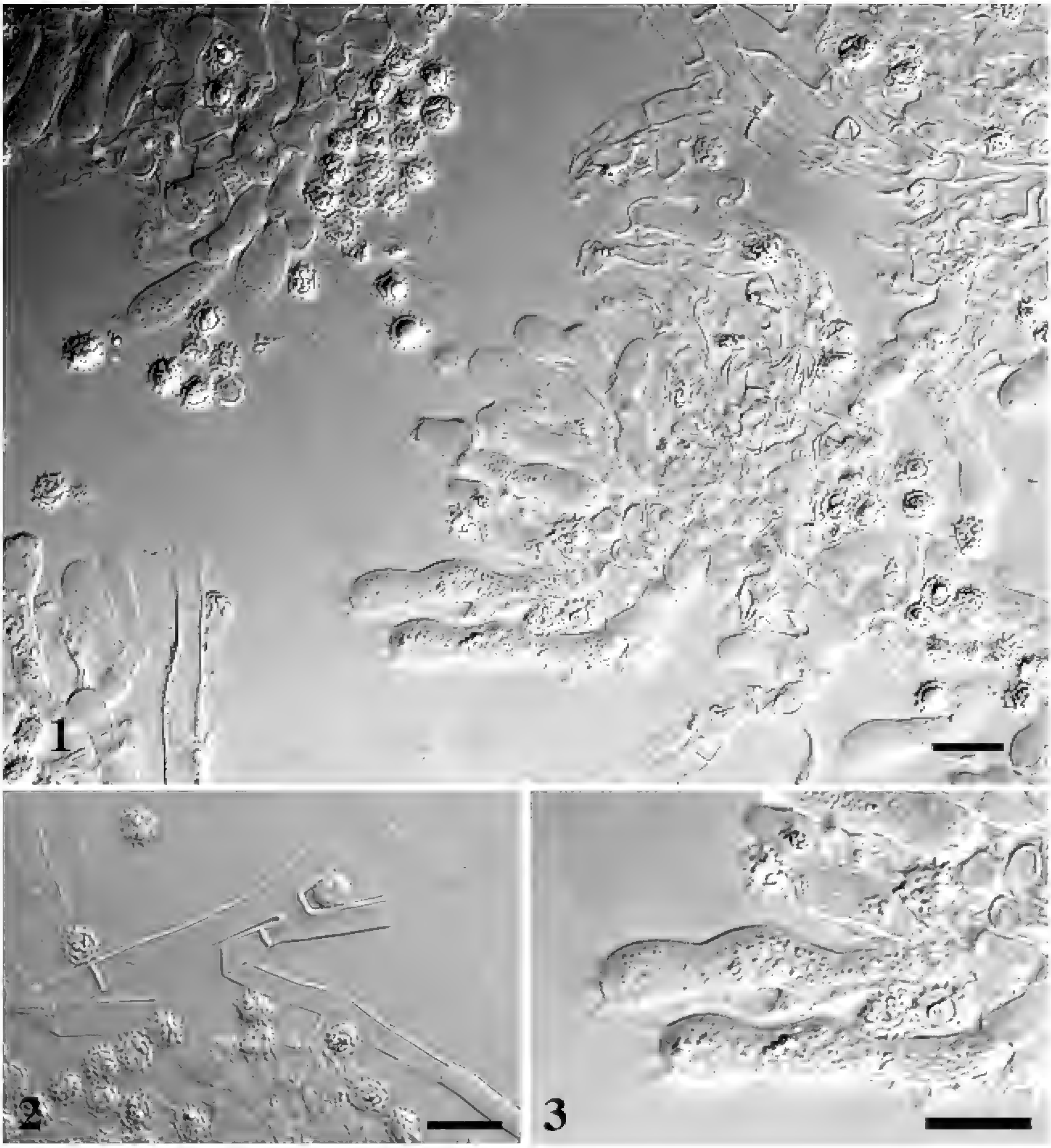
Molecular ecology studies of mycorrhizal fungi have revealed the EcM status of *T. submollis*, *T. zygodesmoides* and *T. echinospora* (see the placement of EcM ITS sequences on Fig. 4). No EcM ITS sequences have fallen into the cluster with sequences of *T. bresadolana*, *T. pulchella* and undescribed species. The most likely explanation for this is that these species are comparatively rare and that plant communities where they grow are still not sampled for EcM studies.

Specimens studied – Italy, Ravenna, Pineta St. Vitale, with *Quercus robur, Q. pubescens, Populus alba, Fraxinus ornus, F. oxycarpa, Ulmus campestris, Salix alba, S. caprea, Cornus mas, Pinus pinea, P. pinaster* and *Crataegus monogyna*. Sporocarp collected under dead, fallen branch of *Crataegus monogyna*, 15 November 2000, leg. A. Bernicchia 7345 (HUBO, **holotype**; TU, **isotype**).

Paratypes in HUBO: Pineta St. Vitale (Ravenna), 15.XI.2000, 7344 on *Quercus*, 7855 on litter, 7856 on *Quercus*, 7857 on *Pinus pinea*, 7858 on *Quercus* and *Hedera*, 7859 on *Quercus*, 7860 on *Crataegus* and litter, 5861 on *Quercus*, 7863 on *Crataegus*; 08.X.2001, 7591 on *Crataegus*; 14.X.2001, 7651 on *Crataegus*, 7652 on *Crataegus*.

Remarks. *T. pulchella* is easily distinguished from known species of the same genus by the yellow to orange colour of the hymenium. Two species that in molecular analyses cluster with *T. pulchella* (Fig. 4) have quite different colour. *T. bresadolana* has a lemon-yellow to green hymenium and an undescribed species from Finland has a whitish hymenium. The spores of the new species are also smaller than in *T. bresadolana*. The last taxon has subglobose spores while *T. pulchella* has mostly globose spores.

However, microscopically the species most similar to *T. pulchella* is *T. pusilla* (Hjortstam 1974). The type material of *T. pusilla* is small and collected in 1969. Therefore we did not take a chance to extract DNA from it. There are a few minor differences like colour of basidioma, size of the basidia, etc.



Figs 1–3. ***Tomentellopsis pulchella*** (HUBO 7345, holotype): **1.** Spores, basidia and hyphae; **2.** Spores and anastomosis of hyphae; **3.** Basidia. Bars = 10 µm.

between these two species but above all spores are distinctly dissimilar. The size of the spores is nearly identical, 4.6–5.5 µm in *T. pusilla* and 4.5–5.5 µm in *T. pulchella,* but the shape of the spores is different. *T. pusilla* spores are in lateral view elliptical and in frontal view clearly subglobose while *T. pulchella* spores are in all views globose or slightly subglobose. Also, *T. pusilla* spores have much shorter spines than *T. pulchella.*

The status of *T. pulchella* as a separate species is also supported by the ITS sequence pairwise base differences (Table 1). The closest taxon is *T. bresadolana,* which ITS sequences differ from the *T. pulchella* sequence by

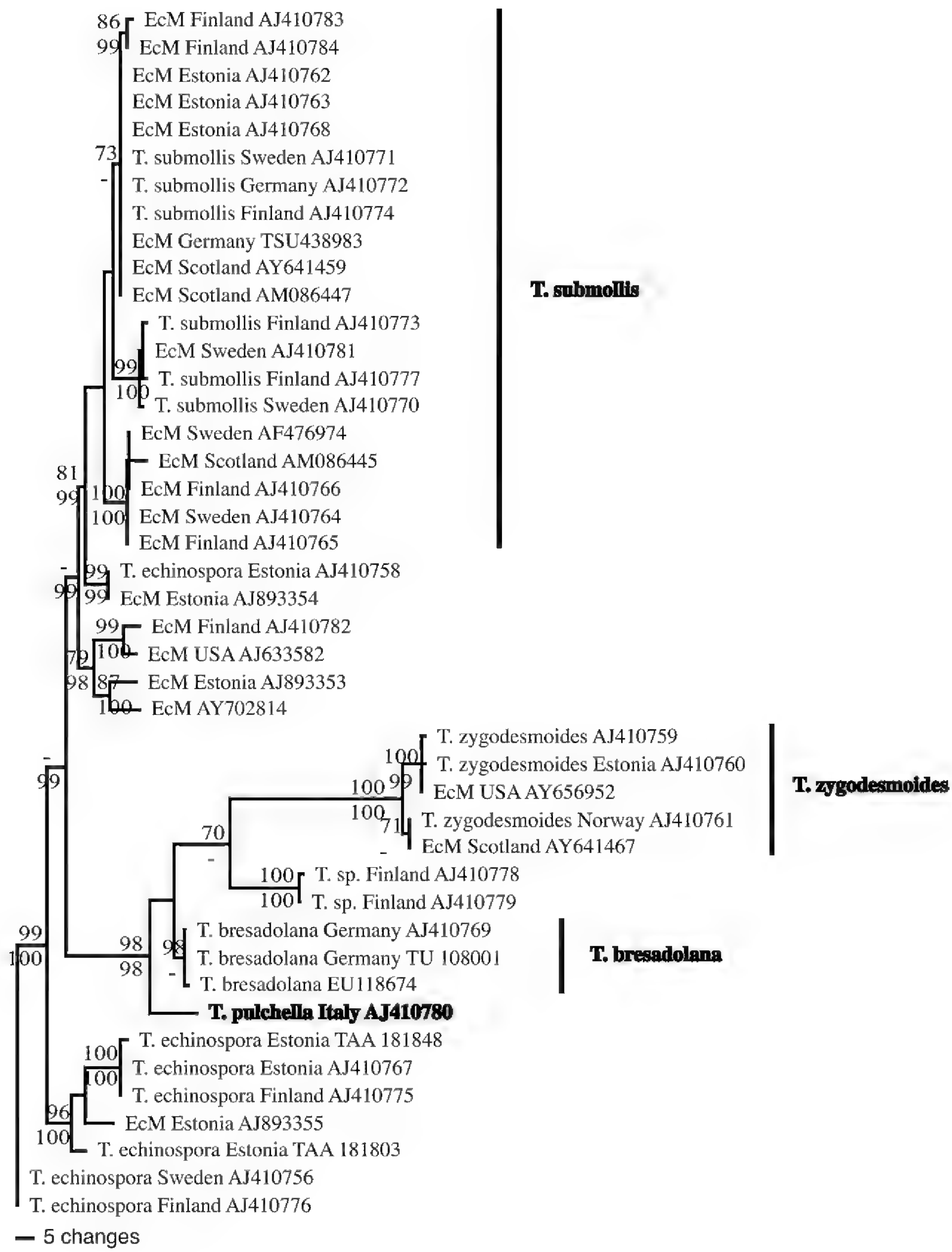


Fig 4. One of the best trees (–ln L = 2392.21980, length = 308, CI = 0.675, RI = 0.890) among 100 equally parsimonious trees depicted as a phylogram. Bootstrap support (≥70%) and posterior probabilities (≥95%) are shown above and below branches.

5.13–5.36%. ITS sequence pairwise base differences are often used in EcM studies for species discrimination. The most commonly used species threshold value is 3% pairwise base difference (e.g. Tedersoo et al. 2003).

Table 1. rDNA ITS sequence pairwise base differences of three *Tomentellopsis* species.

Species pair	Proportion of site differences	Pairwise base difference
T. pulchella versus *T. bresadolana* AJ410796	26/485	5.36%
T. pulchella versus *T. bresadolana* EU118674	27/507	5.33%
T. pulchella versus *T. bresadolana* TU 108001	26/507	5.13%
T. pulchella versus *T. sp.* AJ410778	43/486	8.85%
T. pulchella versus *T. sp.* AJ410779	44/488	9.02%

Kõljalg et al. (2002) did not accept *T. pulchella* as different from *T. bresadolana*. However, they stressed that ITS sequences of this group deviate from each other by 8–9% and therefore probably included two or more species. At that time only one sequence from a well-developed basidioma of *T. bresadolana* was available. In the present study we added two new ITS sequences of *T. bresadolana* from Sweden and Germany, which made the division of the group into three separate species clear. The undescribed *Tomentellopsis* species collected in Finland will be validly published in a forthcoming treatment of the genus.

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The truffle genus *Pachyphloeus* in the U.S. and Mexico: phylogenetic analysis and a new species

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Abstract—A molecular analysis of LSU and ITS portions of rDNA from *Pachyphloeus* ascocarp collections in the United States and Mexico gives strong bootstrap support for four clades within the genus. Two clades include collections from Iowa and Mexico. From one of these, a new species of *Pachyphloeus,* is described from oak woodlands. *Pachyphloeus marroninus* is distinguished from other species of *Pachyphloeus* by the combination of a reddish brown peridium with low, polygonal warts, a solid, white gleba, narrowly clavate asci, and spore spines that are coarse with tips free from the perisporium at maturity. Molecular analyses support the close relationship of this species from Iowa and Mexico, but the variations in sequences may indicate a cryptic species complex.

Key words— ascomycete, taxonomy, hypogeous fungi

Introduction

The genus *Pachyphloeus* was described by Tulasne & Tulasne (1844) based on *P. melanoxanthus* (Tul. & C. Tul. ex Berk.) Tul. & C. Tul. with the following characteristics: 1.) a thick peridium with an outer layer of pigmented cells; 2.) a thick margined orifice stuffed with hyphae, where the interstitial veins come to the surface in a depression on the ascoma; 3.) a prominent basal mycelial tuft; 4.) sterile veins that initially differ in color from the fertile tissue, but later resemble the fertile tissue in color; 5.) and asci with eight globose spores ornamented with spines and irregularly arranged in the ascus. The name *Pachyphloeus* was derived from a combination of Greek words for "thick" and "cortex" (Pegler et al. 1993), a tribute to the ample peridium.

To date *Pachyphloeus* contains 12 described species and one variety: *P. austro-oregonensis* J.L. Frank & Trappe (Frank et al. 2006), *P. carneus* Harkn. (1899), *P. citrinus* Berk. & Broome (1846), *P. conglomeratus* Berk. & Broome (1846), *P. lateritius* Fogel & States (2002), *P. ligericus* Tul. & C. Tul. (1851), *P. macrosporus* Calonge (Calonge et al. 2002), *P. melanoxanthus*, *P. melanoxanthus* var. *xanthocarnosus* Soehner (1936), *P. prieguensis* Mor.-Arr. et al. (Moreno-Arroyo et al. 1996), *P. saccardoi* Mattir. (1903), *P. thysellii* W. Colgan & Trappe (2004), and *P. virescens* Gilkey (1939).

A survey of hypogeous fungi in Iowa from 1997–2000 revealed several undescribed truffle species (Healy 2002, 2003, and unpublished data). Forays for hypogeous fungi in various locations in Mexico from before 1970 to 2008 produced many new records and undescribed species (Trappe & Guzmán 1971, Hosford & Trappe 1980, Cázares et al. 1992, and unpublished data). Morphological and molecular comparisons among similar collections of *Pachyphloeus* from both Iowa and Mexico indicate that some of these undescribed species are closely related. The first such species is described here.

Materials and methods

Data on color and morphology of fresh ascomata (Weber et al. 1997) were recorded, and the specimens photographed and air dried or prepared for microscopy. Colors matched to plates in Ridgway (1912) in quotation marks are followed by the INCC-NBS equivalent (Kelly & Judd 1955) in parentheses. Spores from air-dried specimens were measured in water under 100x. Fifty mature spores from each collection were measured. The holotype and some paratypes of *P. marroninus* sp. nov. were deposited in the Ada Hayden Herbarium at Iowa State University (ISC). Isotypes and other paratypes were deposited at the Oregon State University herbarium (OSC), Instituto Tecnologico de Ciudad Victoria (ITCV), Universidad Autónoma de Nuevo Leon (UNL) and Universidad Autónoma de Tlaxcala (TLXM). Specimens prepared for microscopy were fixed in FAA, embedded in paraffin, sectioned at 10 μm, stained in hematoxylin, and photographed with an Olympus camera. For scanning electron microscopy, paraffin embedded material was sectioned to 50 μm, deparaffinized in xylene, substituted with absolute ethanol, critical point dried in a DCP-1 Denton Critical Point Drying Apparatus (Denton Vacuum Inc., Cherry Hill, NJ), mounted on aluminum stubs with double-sided tape, silver painted around the specimen edges, sputter coated for 120 sec with Au/Pd, and visualized with 10 kV in a JEOL 5800LV SEM. Images were digitally captured. Imaging was done at the Bessey Microscopy Facility at Iowa State University.

Other species of *Pachyphloeus* from the collections of Healy, and J. Trappe were examined microscopically and many of these were included in the molecular analyses. These latter specimens are listed with their collection information and GenBank accession numbers in Table 1.

For molecular analysis, DNA was extracted from previously unexposed portions of the gleba of mature, air-dried ascocarps. Total DNA was extracted with 24:1 chloroform

Table 1 Collection data and GenBank numbers for sequences used in this study.*

Taxon	Voucher ID	Geographic origin, date, collector, herbarium of deposit, canopy spp.	GenBank #
Pachyphloeus cf. *carneus*	RH800	USA: IA, 9-8-00 Healy (ISC), *Quercus alba*	EU543199
P. cf. *carneus*	JT11019	MEX: NL, 10-22-88 Cázares, Trappe, Arnulfo (OSC), *Quercus*, mixed forest	EU543200
P. cf. *carneus*	RH20	USA: IA, 8-31-96 Healy (ISC), *Quercus macrocarpa*	EU543201
P. cf. *carneus*	RH725	USA: IA, 7-27-00 Healy (ISC), *Quercus macrocarpa*	EU543202
P. cf. *carneus*	RH525	USA: IA, 8-8-99 Healy (ISC), under *Quercus macrocarpa*	EU543203
P. cf. *carneus*	RH12	USA: IA, 7-9-07 Healy (ISC), *Quercus alba*	EU543204
P. cf. *carneus*	RH572	USA: IA, 9-9-99 Healy (ISC), *Tilia americana* and *Carya ovata*	EU543205
P. cf. *carneus*	RH756	USA: IA, 8-9-00 Healy (ISC), *Quercus macrocarpa*	EU543206
P. cf. *carneus*	RH518	USA: IA 8-6-99 Healy (ISC), *Quercus alba* and *Carya ovata*	EU543207
P. aarneus	Saylor2026	USA: CA 6-30-84 Saylor (OSC), *Lithocarpus densiflora*	AY500544 [1]
P. aarneus	JT12818	USA: CA 5-5-78 Heblack (OSC), *Quercus agrifolia*	EU543208
P. citrinus	JRWL2497	ITA: Cuneo, 12-9-00 (OSC), Mixed conifer and broadleaved trees	EU543196
P. marroninus	RH299	USA: IA 10-23-98 Healy (ISC, OSC), *Quercus rubra*	EU427549
P. marroninus	RH286	USA: IA 10-2-98 Healy (ISC, OSC), *Quercus alba* and *Q. macrocarpa*	EU427550
P. marroninus	Garcí a 3757	MEX: Nuevo Leon 9-14-83 Garcia (UNL), *Quercus polymorpha*	EU427551
P. marroninus	JT32454	MEX: Tlaxcala 9-20-07 Cázares (TLXM), *Quercus rugosa*, and *Q. crassifolia*	EU543209
P. cf. *melanoxanthus*	RH735	USA: IA, 7-28-00 Healy (ISC), *Quercus alba* and *Tilia americana*	EU543193
P. cf. *melanoxanthus*	RH195	USA: IA, 8-4-98 Healy & Gardner (ISC), *Quercus alba*	DQ191674[2]
P. melanoxanthus	MM1860	ITA: Venezia, Jan. 1999 Macchioni (OSC), *Ostrya* and *Quercus*	EU543194
P. virescens	RH279	USA: IA, 7-27-00 Healy (ISC), *Quercus macrocarpa*	EU543198
P. thysellii	JT13182	USA: WA, 8-19-93 Colgan (OSC), *Pseudotsuga menziesii*	EU543197
Pachyella clypeata		USA: IA, 9-18-05 Healy (ISC), riparian deciduous woods	EU543195
Peziza infossa		USA: CA	DQ974817[3]
Peziza cf. *badio-confusa*	RH7	USA: IA, 5-28-06 Healy (ISC), oak-hickory woods	EU571229

* 1. Hansen et al. 2005 as *P. citrinus*; 2. Tedersoo et al. 2006; 3. Smith et al. 2007.
All other sequences originate from this study.

: isoamyl alcohol. Both the internal transcribed spacer region (ITS1, 5.8S, and ITS2) and part of the ribosomal large subunit (LSU) locus were amplified using universal fungal primer set ITS5 - LR5 (Bertini et al. 1999, Vilgalys & Hester 1990). The PCR protocol began with an initial denaturation at 94 °C (3 min), followed by 35 cycles at

94 °C (2 min), 50 °C annealing (45 sec), and a 72 °C extension (1.5 min), with a final extension at 72 °C (7 min). Each 25 μl PCR reaction consisted of 4 μl dNTPs (1.25 μM), 2.5 μl PCR buffer, 1 μl BSA, 1.25 μ primer 1 (10 μM), 1.25 μl primer 2 (10 μM), 0.15 μl *Taq* DNA polymerase (1 μM/μL), 4.8 μl water, and 10 μl DNA extract (~10 ng / μl). Two μl of each PCR product was loaded into a 1.0% agarose gel buffered with TAE buffer and stained with 2 μl SYBR safe (Invitrogen, Carlsbad, CA) per 80 ml gel. Gel electrophoresis products were viewed on a GelDoc XR imager (Bio-Rad Laboratories, Inc., Hercules, CA). Qiagen Quick-Clean columns were used to clean PCR products prior to sequencing. Sanger bidirectional sequencing was performed using Big Dye chemistry version 3.1 (Applied Biosystems, Foster City, CA) with ITS5 (forward) and LR5 (reverse). DNA sequences were determined on an ABI3700 (Applied Biosystems, Foster City, CA).

DNA sequences were manually edited by use of Sequencher 4.0 (Gene Codes, Ann Arbor, MI), forward and reverse sequences were assembled, and ambiguous regions at the ends were trimmed. Both ITS and LSU sequences were queried against the NCBI public database GenBank with the BLASTN algorithm to compare with other sequences and to verify that sequences were of the target group. DNA sequences were aligned manually using MacClade 4.0 (Maddison & Maddison 2002). Ambiguously aligned regions were excluded from the alignment. Phylogenetic analysis was conducted on both the ITS and LSU alignments individually and combined, with unweighted parsimony heuristic criteria using PAUP 4.0b10 with 1000 random addition sequences and 5000 bootstrap replicates (Swofford 2001). Two independent maximum likelihood analyses based on a general-time-reversible 6-parameter model of evolution were run using the software program GARLI and included 100 bootstrap replications (Zwickl 2006). Outgroups in these analyses were chosen on the basis of preliminary data on phylogenetic relationships across the genus *Pachyphloeus* (Læssøe & Hansen 2007). The ITS and LSU sequences produced in this study were deposited in GenBank under the accession numbers EU427549–EU427551, EU543193–EU543209 and EU571229.

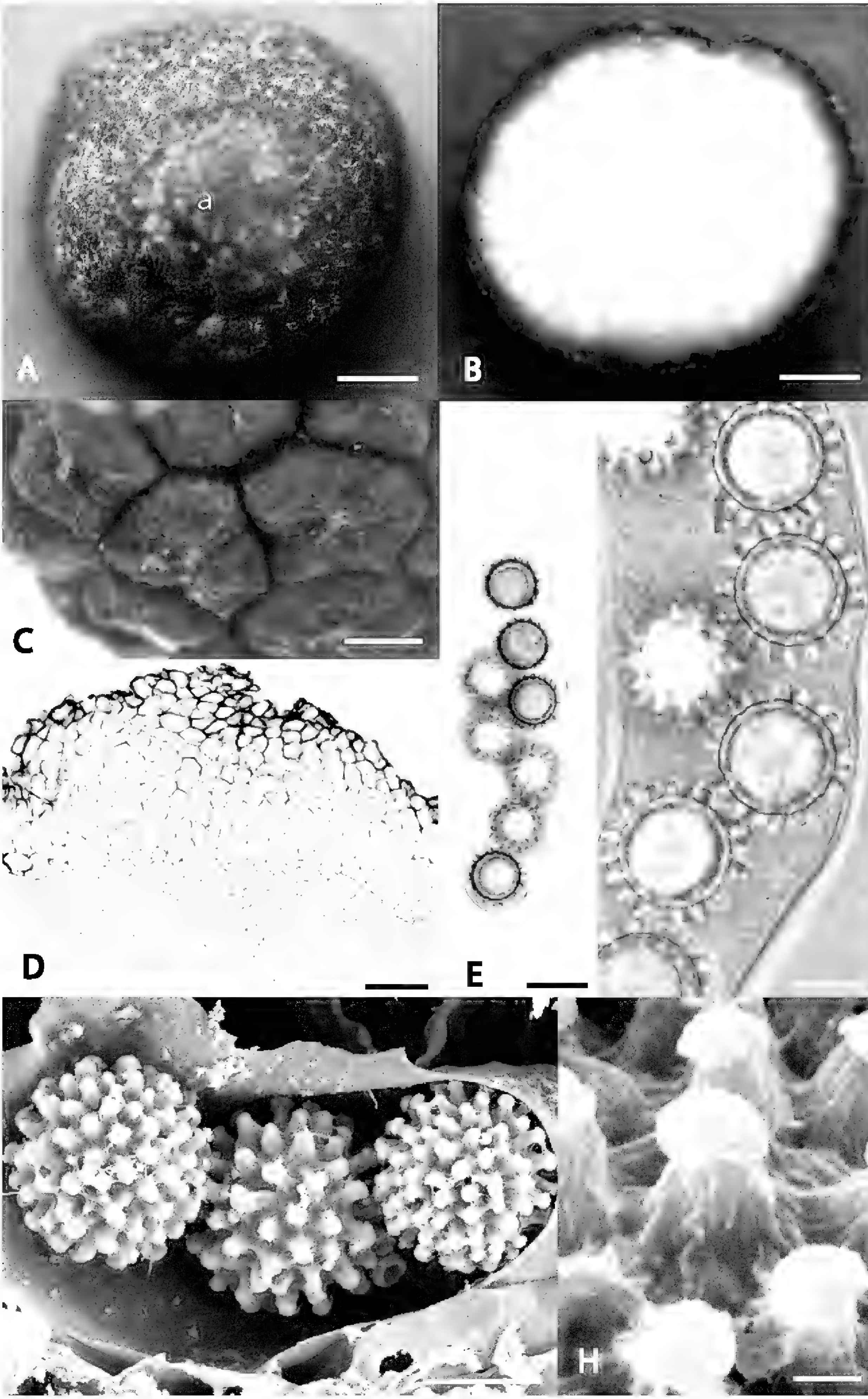
Taxonomy

Pachyphloeus marroninus Healy, Bonito & G. Guevara, **sp. nov.**

MycoBank MB 511872 GenBank EU427549 — Figs. 1 A–H

Ptychothecium subglobosum, usque ad 1.7 × 1.5 × 1.3 cm, ordore ingrato, pagina verrucosa, marronina. Excipulum ectale textura angulari; excipulum entale textura intricati. Gleba solida, alba, venis fertilibus, in siccitate cremicolor. Asci clavati, haud amyloidei, octospori, in vallo dispositae. Sporae hyalinae, globosae, 19–22 μm latae ornamentum spinarum includens (1.5–)2–2.5(–3) μm altarum.

Fig. 1. *Pachyphloeus marroninus* images. A. Ascocarp as viewed from top, showing areole (a). (Scale bar = 3 mm) B. Ascocarp longisection showing gleba with opaque white sterile veins and translucent pallid fertile veins. (Scale bar = 3 mm) C.–F. Light microscopy. C. Pyramidal wart-like warts on the peridium. (Scale bar = 0.5 mm) D. Longisection of ascocarp showing an excipular wart composed of textura angularis. (Scale bar = 100 μm) E. Ascus. (Scale bar = 20 μm) F. Ascus with details of spores. (Scale bar = 10 μm) G–H. Scanning electron micrographs of spores and spore spines. G. Spores in an ascus. (Scale bar = 10 μm) H. Single spine of a spore. (Scale bar = 1 μm)


a
A
B
C
D
E
H

HOLOTYPUS: USA, IOWA, Winneshiek Co., Upper Iowa River Public Access Area 2 October1998, *RH286* (ISC); Isotype (OSC)

ETYMOLOGY: Latin, *marroninus* (maroon) refers to the maroon color of the ascocarp.

Technical description of holotype

MACROCHARACTERS—PTYCHOTHECIUM (ascomata) radially symmetrical to slightly compressed, 1.7 × 1.5 × 1.3 cm broad (FIG. 1A, B), sculptured with low, flat, polygonal warts with 4–5 sides, each about 0.3–1 mm broad (FIG. 1C), "Morocco red" (moderate reddish-brown) to "maroon" (dark reddish-brown); ascomal apex with a relatively smooth, "orange-rufous" (strong orange) areole (FIG. 1A a) 11 × 9 mm where internal sterile veins emerge, and a white to cream-colored basal mycelial tuft; odor none at first, of burned potatoes when mature, or when enclosed in a container for several hours. GLEBA white with translucent whitish veins at all stages (FIG. 1B), ascus-lined veins becoming "light drab" to cream-colored with drying.

MICROCHARACTERS—ECTAL EXCIPULUM (peridium) reddish-brown as viewed under bright field light microscopy, 368–630 µm thick excluding warts, warts 158–263 µm high, composed of textura angularis (pseudoparenchyma) with cells ± isodiametric, 26–35 µm broad, the walls of the outermost cell 2.5–4 µm thick, thinning on interior cells, grading to the ENTAL EXCIPULUM (subhymenium) of hyaline textura intricata next to gleba with hyphae 7–10 µm broad (FIG. 1D). Basal tuft of mycelia 5–10 µm broad, some with granular incrustations. GLEBAL hyphae 7–10 µm at the septa, some cells swollen to 12 µm. ASCI forming a palisade, clavate to clavate-cylindrical, usually slightly ventricose, pedicellate; 162.5–210 × 35–40 µm, with 8 irregularly uniseriate to biseriate spores (FIG. 1E), non-reactive to Melzer's solution with pretreatment in 3% KOH. SPORES globose (Figs. 1E-H), 14–17 µm (avg. 15.5 µm), mostly 16–17 µm excluding spines, 19–22 µm (avg. 20.3 µm) mostly 20 µm including spines; spore wall 1.5–2 µm thick, hyaline to chlorinous, and few greenish yellow, ornamented with coarse, acute to capitate spines (1.5–)2–2.5(–3) µm tall, 1–2 µm wide at spine base (FIG. 1H), occasionally spines joined in 2's; 7–9 spines traverse spore surfaces.

ADDITIONAL *P. MARRONINUS* COLLECTIONS EXAMINED—PARATYPES: UNITED STATES. IOWA: Boone Co., Ledges State Park, 21 Jul 1999, R.Healy *482* (ISC, OSC). UNITED STATES. IOWA: Winneshiek Co., Cardinal Marsh Wildlife Access Area 23 Oct 1998, R.Healy *299* (ISC, OSC). Similar collections examined: MEXICO. Nuevo Leon: Municipio de Santiago, El Cercado 14 Sep 1983 J. García *3757* (UNL), Col. Los Pescadores, 10 Aug 1983 J.García *3764* (ITCV). TAMAULIPAS: Municipio de Ciudad Victoria, Torre de Microondas "Las Mulas", 11 Nov 2006 G. Guevara *891*, G.Guevara *896* (ITCV) TLAXCALA: 1 km E of San Francisco Temezontla, Municipio Panotla Tlaxcala (elevation 2600 m, lat 19 20 76, long 98 16 42), 20 Sep 2007 E. Cazares, *JT32454* (TLXM).

Comments: The paratypes from Iowa were similar to the holotype in all respects. Macroscopically, the Mexican collections were similar to *P. marroninus* except the ascoma were deeper gray-brown in color, lacking the reddish hues of the Iowa collections. Spore spines of Garcia3757 average 1.5 µm tall on average. Spore spines of JT32454 were only 1 µm tall on average.

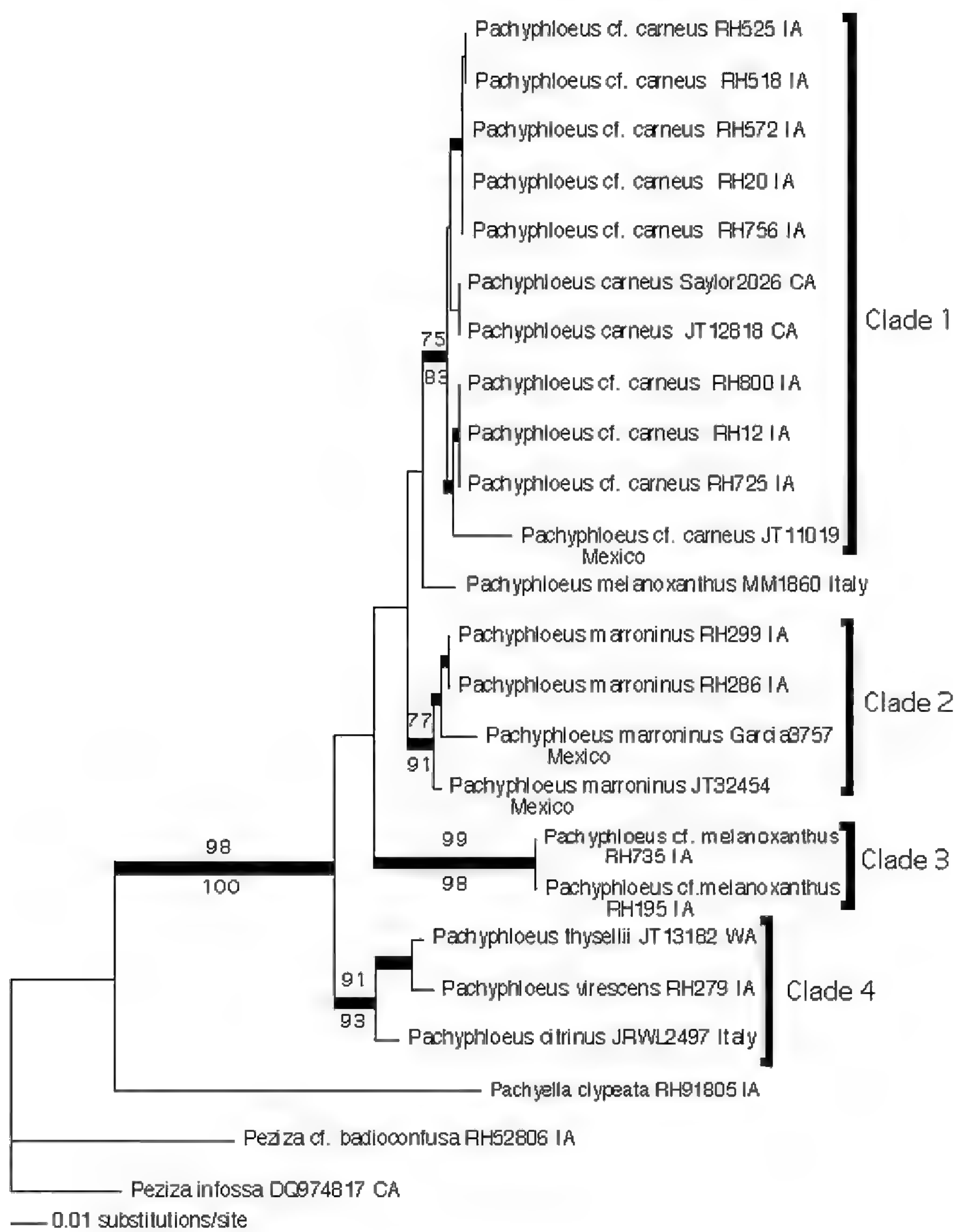


Fig. 2. Phylogenetic reconstruction of the genus *Pachyphloeus* based on ITS and LSU rDNA from 22 taxa, showing the placement of *Pachyphloeus marroninus*. Topologies based on parsimony and maximum likelihood were congruent at all supported nodes; the most likely tree is presented here. Thickened branches indicate those nodes that are supported by bootstrap values of 70% or more. Numbers on the nodes are maximum parsimony (top) and maximum likelihood (bottom) bootstrap values. Taxa are labeled by their collection name and location.

Discussion

Clade 1 is composed of *Pachyphloeus* with orange-colored ascomata with flattened polygonal warts and brown spores. The only *Pachyphloeus* described with an orange ascoma is *Pachyphloeus carneus* from California (Harkness 1899). Helen Gilkey sent a specimen of *P. carneus* to Eduard Fischer, who compared it with the type of *P. citrinus* and determined them to be synonymous (Gilkey 1916). Gilkey tentatively accepted his opinion but with reservations, because the ascomata of North American specimens were consistently bright orange in color compared to the dark brown ascomata with yellow peridial papillae described for European specimens (Berkeley & Broome 1846). She also noted North American specimens were larger. In addition, *P. citrinus* has rounded to cone-shaped warts on the ascoma, rather than the polygonal ones of the species in clade 1. Subsequently, orange *Pachyphloeus* species, such as those included in our study, have been identified as *Pachyphloeus citrinus*. Our results indicate the species in clade 1 are distinct from a *P. citrinus* from Italy in clade 4. We submit that the name *P. citrinus* has been misapplied to the orange-colored species of *Pachyphloeus* from North America and Mexico, and that *P. carneus* is the correct name for this species. Diversity is apparent in this clade, and subsequent morphological and molecular analysis of additional collections may reveal more species.

Clade 2 is represented by *Pachyphloeus marroninus*. The holo- and paratypes of *P. marroninus* differ from other species of *Pachyphloeus* in the combination of dark reddish-brown peridium with polygonal warts, orange areolar area, white gleba with pallid veins at maturity, narrowly clavate asci, and hyaline to chlorinous spores with coarse spines that do not tend to form obviously inflated tips or perisporium. Sequences differ slightly between the Mexican and Iowa collections, which prompted us to look more carefully for morphological differences. Macroscopically these collections are similar in size, and peridial structure. The Iowa collections have a reddish-orange hue, whereas the Mexican collections are dark grayish brown. The spore spines also differ in length. This may be a cryptic species complex that needs analyses of additional collections.

Details of the spines for most *Pachyphloeus* spp. are difficult to distinguish with light microscopy because of the small spore size (averaging 17–20 µm) and complex ornamentation. Adding to the difficulty in viewing spore details, some species have a perisporial covering that develops along the inside surface of the outer delimiting membrane, as is the case in *P. carneus* (Healy 2002). This perisporium obscures the shape of the spines, and makes the interpretation of them when viewed with light microscopy confusing. *Pachyphloeus marroninus* lacks this perisporium; the coarseness of its spines and absence of a perisporium render its spore ornamentation distinct.

Among described species that have similarly colored ascomata, *Pachyphloeus lateritius* differs in having minutely warted spores; *P. austro-oregonensis* has yellow veins, and canal-like openings in the gleba; *P. thysellii*, has a minutely verrucose ascoma, yellow veins and patches among the excipular warts, and spores with very fine spines. All other species are easily differentiated by the colors of both ascoma and gleba.

Clade 3 is composed of only two collections of a single species from Iowa, similar in color to *P. melanoxanthus*, but not clustering with that species in the phylogram. This species is as yet undescribed.

Clade 4 is composed of three species from Washington, Iowa and Italy. Morphological features shared by *P. thysellii* and *P. virescens* include brown ascomata with conical warts, yellow sterile veins and subglobose asci. *P. citrinus* has most of these features, but its asci are clavate.

In general, only those who seek truffles find them. Consequently, collection sites of a species are often far apart. Oaks are the most frequently cited associates of *Pachyphloeus* spp. (Fogel & States 2002, Montecchi & Sarasini 2000), and are the predominant canopy species for collections in Iowa and Mexico. Frank et al. (2006) demonstrated the mycorrhizal relationship of *P. austro-oregonensis* with *Quercus garryana* and reported DNA of this species in scats of mycophagous deer mice (*Peromyscus maniculatus*), a common species in woodlands and prairies from Canada to Central Mexico. The main dispersal mode of truffles is via mycophagy by small woodland mammals (Trappe & Claridge 2005). We hypothesize that *P. marroninus* occurs in oak woods from Iowa into Mexico, but data are missing from woodlands between the collection sites for lack of searching. Oaks presently occur contiguously from Canada to the Rio Grande River and into Mexico. Even disjunct oak communities in Mexico are remnants of more extensive forests and woodlands in the Tertiary and Quaternary (Valiente-Banuet et al. 2006). Hence the present disjunct distribution of *P. marroninus* probably reflects a historically continuous distribution. Moreover, transport of spore-bearing small mammals by preying raptors could account for long distance dispersal between separated oak stands (Trappe & Claridge 2005).

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Ectomycorrhizae between *Amanita rubescens* and Himalayan spruce (*Picea smithiana*) from Pakistan

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Abstract — Field ectomycorrhizae of *Amanita rubescens* with *Picea smithiana* are described for the first time. Ectomycorrhizal roots were sampled beneath the sporocarp from the rhizosphere of the host plant. The sporocarps and ectomycorrhizae were characterized morphologically and anatomically. The most important characters of the ectomycorrhizae are a monopodial mycorrhizal system, white to cream colour of the mantle, hyaline emanating hyphae, and thick hairy rhizomorphs emerging mostly from restricted points. All mantle layers are plectenchymatous. Hyphae lack clamp connections forming rings. Rhizomorphs are composed of thick central hyphae without septa. The diameter of the rhizomorphs is narrower than other known ECM of *Amanita* spp. This association is reported for the first time from Pakistan.

Key words — *Amanitaceae*, ectomycorrhizogenous, Mukshpuri, *Pinaceae*

Introduction

Himalayan spruce (*Picea smithiana* (Wall.) Boiss.) is native to western Himalaya and adjacent mountains from northeast Afghanistan to central Nepal. It grows at altitudes of 2400–3600 m a.s.l. in forests together with *Cedrus deodara* (Roxb.) D. Don, *Pinus wallichiana* A.B. Jacks., and *Abies pindrow* (Royle ex D. Don) Royle. It is valued for its use in the pulp industry as a source of paper. Although it is of marginal use as fuel, it yields a fairly good charcoal (Hill 1952). In Pakistan Himalayan spruce is found in northern Pakistan (Kurram Agency, Chitral, Swat and Gilgit eastwards), Murree hills (Nathia Gali, north slope of Mukshpuri) and Kashmir (Stewart 1972). This tree grows in acidic, neutral and basic (alkaline) soils as well as in very acidic and nutritionally poor soil. *Picea smithiana* overcomes all these extreme soil conditions due to its ability to form ectomycorrhizae with forest mycoflora (Huxley 1992). Field ectomycorrhizae (ECM) of *Picea* have already been described. About 162 ECM morphotypes of different macrofungi have been recorded with *Picea* spp. (De Roman et al.

2005, Agerer 2008), but none with species of *Amanita*. *Amanita* spp. have been reported as ectomycorrhizal with *Betula pendula, Cedrus deodara* and *Pinus* spp., (Cuvelier 1990, Daniele et al. 2005, Agerer 2006).

Amanita is one of the most studied and well-known agaric genera. It is characterized mainly by its terrestrial, mostly ectomycorrhizogenous and fleshy basidiomes (Gonzalez et al. 2002). In Pakistan, *Amanita* is represented by 12 species, mostly in Himalayan moist temperate forests. These forests are a hot spot for the diversity of ectomycorrhizal macromycetes particularly amanitas from this country (Tulloss et al. unpublished data). *Amanita rubescens* Pers. has been reported from Murree Hills and northern areas of Pakistan under *Abies pindrow*, *Picea smithiana* and *Pinus* spp. in coniferous forests (Murakami 1993). This fungus was originally described in northern Europe associated with *Quercus* and *Fagus*. Neville & Poumarat (2004) mention its association with *Abies alba* Mill., *Pinus pinaster* Aiton, *P. sylvestris* L. as well as *Castanea sativa* Mill., *Quercus ilex* L., *Q. pubescens* Willd., and *Q. suber* L.

During the study of biodiversity of mushrooms and ectomycorrhizae of Himalayan moist temperate forests of Pakistan (Niazi et al. 2006, 2007), *Amanita rubescens* was found under *Picea smithiana*, and their association was confirmed by tracing the mycelial connection from fruit body to the morphotypes (Agerer 1991).

The morphological and anatomical description of mycorrhizae (Miller et al. 1991) and identification of their fungal partners are pre-requisites for recognizing mycorrhizal diversity in an ecosystem. In the present study, field ectomycorrhizae of *A. rubescens* and *P. smithiana* are reported and characterized in detail for the first time from Pakistan.

Materials and methods

Study Area

The study area is located in Murree Hills of Himalayan moist temperate forests of Pakistan. These forests present dominant stands of *Abies pindrow* with varying stands of *Cedrus deodara, Picea smithiana, Pinus wallichiana*, and *Taxus wallichiana* Zucc. intermixed with deciduous or broad leaved trees. The dominant understory vegetation consists of patches of *Viburnum cotinifolium* D. Don, *Skimmia laureola* (DC.) Dcne., and *Urtica dioica* L., among others (Stewart 1972). All these sites are located between 1830 and 3050 m a.s.l. with an annual precipitation between 5000 and 6000 mm (Champion et al. 1965).

Sampling and identification

The study area was visited during rainy seasons from July, 2006 July, 2007. Sporocarps were photographed and field notes were taken. Soil blocks of 10 × 5 cm were concurrently collected below fruit bodies. The rooted soil samples were taken out with a sharp digger and then wrapped in polythene bags to

avoid evaporation. Samples were examined under a stereomicroscope at 40× magnification for hyphal connections leading from sporocarps to fungal mantle (Agerer 1991). ECM morphotypes were placed in water and cleaned with a camel hair brush. These were photographed under a Wild Heerbrugg stereo microscope.

Microscopic characterization

The epigeous basidiocarps were analyzed macroscopically (colour, lamellae, shape.) and microscopically (basidia, basidiospores, cystidia) following Reid's (1984) methodology. Voucher specimens were deposited in the Herbarium, Department of Botany, University of the Punjab, Lahore, (LAH) Pakistan. Morphological and anatomical characterizations of the mycorrhizae were carried out by following the terminology of Agerer (1991). Individual tips of mycorrhizae were examined under the microscope. These surface views were observed in detail; measurements were taken and traced out using a camera Lucida. The internal structures of rhizomorphs, and emanating hyphae were also measured and traced out. Color Reactions of fungal tissues of morphotypes were noted with Melzer's reagent, 10% KOH, and lactic acid.

Results

The direct attempt to identify ectomycorrhizae of *Amanita rubescens* by tracing hyphal connections between the stipe base of sporocarp and mycorrhizal root tips was successful.

Description of the basidiocarp of *Amanita rubescens* (Fig. 1 A)

Pileus 60–105 mm wide, reddish brown at centre, white to cream at margin, hemispheric at first, then convex to broadly convex to planar, umbonate, shiny, dry, non appendiculate and non striated margins: Flesh up to 4–5.5 mm thick at disk, Universal veil present, prominent as oblong to roundish dull red or reddish brown to pale brownish gray small warts, easily removable. context white, turning reddish when bruised or cut. margins without striation or minutely striated. Lamellae free to adnate, crowded, white, sometimed discoloring reddish, 5–15 mm broad. lamellulae truncate, common, evenly distributed, of diverse length, present between every pair of lamellae. Stipe 50–145 × 10–23 mm, equal or slightly bulbous toward base, notably longer than pileus width; base with volval scales or zones, without rim: whitish becoming stained pinkish to dirty red, smooth but sometimes with flakes. partial veil superior, thick, membranous, moderately broad, skirt-like, persistent, becoming cream, collapsing and tearing, up to 12 mm long. universal veil present as white or pinkish flakes or warts on lower side of stipe. Odor and taste not recorded.

Macrochemical Tests: none performed.

Basidiospores: (7.5–)8.0–10.5(–12.5) × (5.0–)5.4–7.0(–8.0), ellipsoid to broadly ellipsoid or elongated, hyaline, thin-walled, smooth, amyloid, subglobose to ellipsoid; apiculus sublateral, cylindric; contents dominantly monoguttulate, with or without additional small granules, occasionally granular; color in deposit white. Basidia: 18–24 × 8–10 µm, 2–4 sterigmata, thin walled, clavate.

Habitat And Distribution: Solitary, under *Picea smithiana*. Pakistan: At 2400–2580 m a.s.l.

Collections Examined: PAKISTAN: N.W. FRONTIER PROV.—Hazara Distr. – On the way towards Mukshpuri, 12.viii.2006 A. R. Niazi 12806 (LAH).

Description of ECM of *Amanita rubescens*

Morphological characteristics (Fig. 1 B)

Mycorrhizal system monopodial pinnate, 4–12 mm long with axis 0.5–2 mm thick, sometime profusely branched forming clusters, white when young, turns pale brown when old. Thick mantle layer appearing silvery, opaque, no host tissue visible, but in few places white patches. Unramified ends straight to slightly bent, (0.5–)1.5–2.5(–5) mm long, 0.4–0.6 mm diam, slightly swollen. Mantle surface white to shiny, smooth to rough due to soil particles, water and air trapped among mantle hyphae. Emanating hyphae frequent, white, and thin, up to 3 µm, sometimes surrounding the unramified ends. Rhizomorphs abundant, white, up to 0.15 mm thick, roundish in cross-section, smooth or hairy with few emanating hyphae, rhizomorphs frequently and repeatedly branched, slightly swollen at base, arising mostly from restricted points, rarely from base. Sclerotia lacking.

Anatomical characteristics of mantle in plan views (Fig. 1 C–D)

Mantle plectenchymatous in all layers. Outer Mantle layer plectenchymatous, loosely net-like arrangement, hyphae branched and septate; rounded and cylindric hyphae, 14–25 µm long, 2–3.5 µm diam, cell wall thick, up to 2 µm; sometimes in ring-like arrangement, simple H-type anastomosis among few parallel hyphae, white to hyaline, smooth surface, without clamps. Inner Mantle layer densely plectenchymatous; hyphae closely packed with few interhyphal spaces, entangled with each other, branched, septa without clamps; hyphal cells rounded to cylindric, hyaline , (10–)14–17(–24) µm long, 2–3 (–4) µm diam, smooth-walled, simple or fused anastomoses;. Very tip slightly yellowish, plectenchymatous arrangement, hyphae forming a dense mycelial mat, 3–4.5 µm diam. CROSS Section mantle 42 µm thick, differentiated into plectenchymatous layers, cortical cells with Hartig net in 2–3 rows.

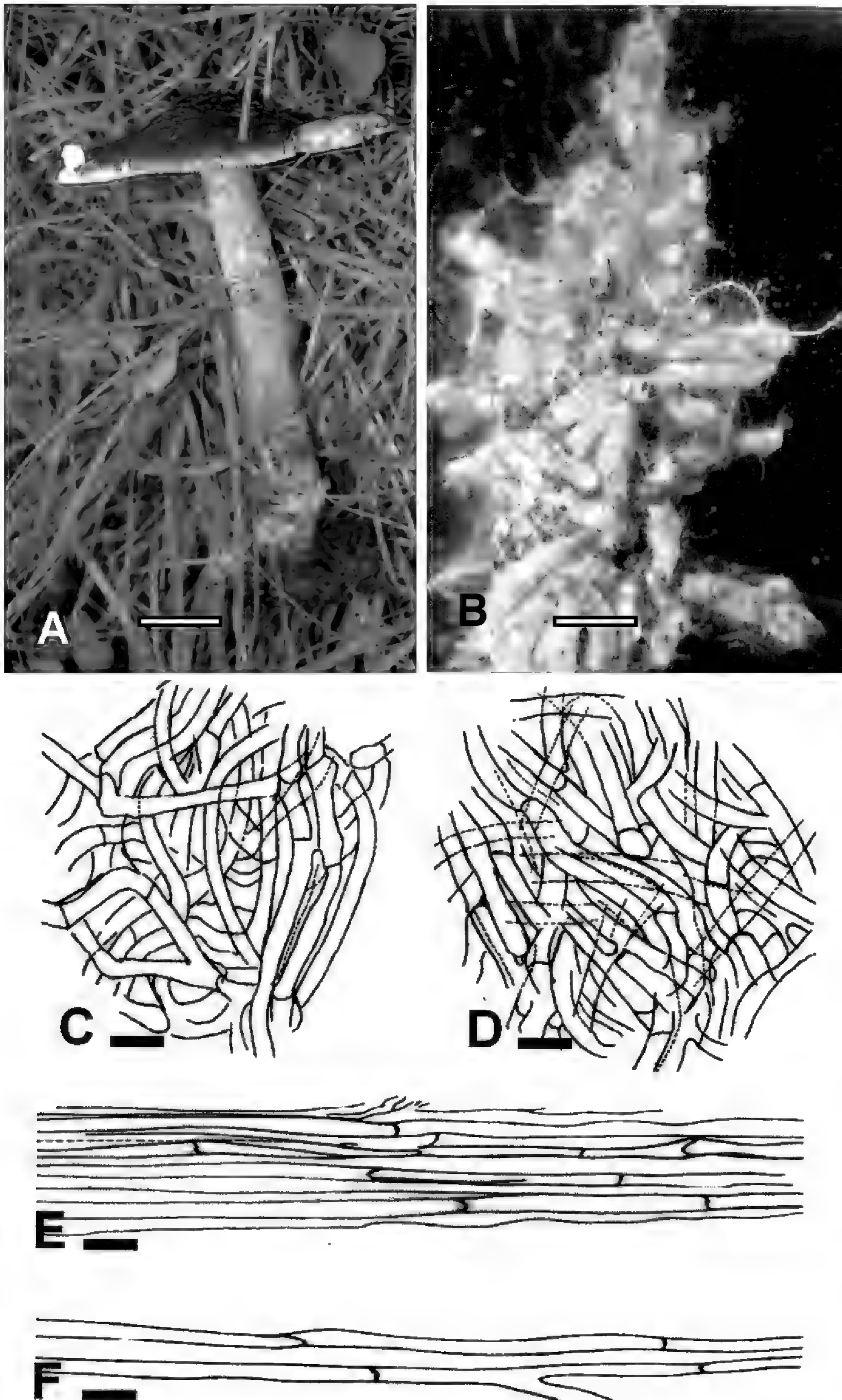

Fig. 1. (a) Amanita rubescens (b) Ectomycorrhizal system (c) outer mantle layer (d) inner mantle layer (e) Internal view of rhizomorph (f) Emanating hyphae.
Scale bar = 2 mm for A and B, 20 *μm for* C–F.

Emanating hyphae emerging out from outer surface. Longitudinal Section plectenchymatous hyphae running parallel, entangled with each other forming a compact inner layer, penetrating into cortical region, forming dense finger-like network among cortical cells, reaching to endodermis.

Anatomical characteristics of emanating elements (Fig. 1 E–F)

Rhizomorphs up to 130 µm thick, wide, rounded to flat, composed of closely packed parallel hyphae; hyphae smooth walled, rarely branched and septate; hyphal cells rounded to cylindric, 10–16 µm long, 3–4 µm diam, cell walls thick, up to 0.5 µm; sometime fused with each other with or without any particular type of anastomosis. A wide central hypha also observed, up to 5 µm diam, thick walled, up to 0.5 µm, incomplete septa without clamp connections. Emanating hyphae white, 2–3 µm diam, 150 µm long, straight, septate, without clamps, branched. Cystidia and chlamydospores not observed.

Color Reactions: 10% KOH-no reaction, Melzer's Reagent-bluish, Lactic acid-no reaction.

Voucher Specimen: Ectomycorrhizae under *Picea smithiana*, in Herbarium, Department of Botany, University of the Punjab, Lahore, Pakistan. A. R. Niazi #AR1021 (LAH). Fruit bodies examined; Pakistan, Khanspur-Ayubia, at 2135 m (LAH).

Discussion

The *Amanitaceae* is a well known ectomycorrhizal family that falls in the Euagaric clade (Binder et al. 2005). Up to now, field mycorrhizae of three *Amanita* spp. have been described in detail: *A. citrina* Pers. (Mleczko 2004), *A. muscaria* (L.) Lam. (Uhl 1988) both with *Pinus sylvestris* and *Cedrus deodara* (Daniele et al. 2005), *A. strobiliformis* (Paulet ex Vittad.) Bertill. with *Betula pendula* Roth (Raidl & Verma 2006, Agerer 2006). The ectomycorrhizal fungus, *Amanita rubescens*, is reported here for the first time growing under *Picea smithiana* and associated mutualistically, and their mycorrhizae are morphologically and anatomically described. The ECM morphotypes of these *Amanita* spp. including the one described here share common features such as a smooth to silvery mantle surface of white to off-white to yellowish colour, plectechymatous outer mantle, and the presence of rhizomorphs with a wider central hyphae and the ring-like arrangement of hyphae in the outer plectenchymatous layer.

The ECM similarities between *A. rubescens–P. smithiana* and *A. strobiliformis –B. pendula* are a plectenchymatous mantle in all layers and a compact rhizomorph with few emanating hyphae. However, *A. strobiliformis* ECM can be separated from the ECM of *A. rubescens* since it presents geniculate hyphae in the mantle surface, a wider central rhizomorph hypha, and a negative Melzer's reaction.

All known *Amanita* ECM morphotypes can also be differentiated based on the size of the central hyphae of their rhizomorphs. The rhizomorph of *A. rubescens* differs from the other three morphotypes by its much narrower central hyphae, up to 5 µm, compared with central hyphae up to 10 µm in *A. strobiliformis*, 15 µm in *A. muscaria*, and 24 µm in *A. citrina*. The rhizomorphs of *A. rubescens* do not contain crystals, while *A. citrina* has characteristic angular crystalloids in its rhizomophs (Mleczko 2004).

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Fructification of *Collybia cirrata* on mummified gleba of *Bovista dermoxantha* in Hokkaido, Northern Japan

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Abstract — Fructification of *Collybia cirrata* on mummified gleba of *Bovista dermoxantha* is newly recorded from Daisetsuzan volcanic group, Hokkaido, Northern Japan. Also, it is the first report of *C. cirrata* in Japan. Macro- and microscopic characteristics and unusual habitat of this fungus are described and illustrated based on Japanese specimens.

Key words — gasteromycetes, host fungus, *Lycoperdaceae, Tricholomataceae*

Introduction

Collybia (Fr.) Staude sensu Antonín & Noordeloos (1997) comprises four species, *C. tuberosa* (Bull.) P. Kumm., *C. cirrata*, *C. cookei* (Bres.) J.D. Arnold and *C. racemosa* (Pers.) Quél. These are small, grayish to whitish agaricoid mushrooms that share a unique habitat, fruiting on the remains of dead fleshy mushrooms (Hughes & Petersen 2006). Hughes et al. (2001), however, separated *C. racemosa* from the rest based on a molecular study and described the new genus *Dendrocollybia* for it with *D. racemosa* (Pers.) R.H. Petersen & Redhead as sole species. Therefore, now only three species remain in *Collybia* sensu stricto.

During our floristic investigation of subarctic and subalpine to alpine zones of Daisetsuzan volcanic group, Hokkaido, Northern Japan, we collected an unusual small agaric that was associated with the mummified gleba of dead lycoperdaceous fungus. According to our morphological observations, we identified this agaric as *C. cirrata* and recognized the host fungus as *Bovista dermoxantha* (Vittad.) De Toni. Hitherto, several species of *Lactarius* Pers.,

Russula Pers. and a polypore, *Meripilus giganteus* (Pers.) P. Karst. have been identified as the host mushrooms of *C. cirrata* (Noordeloos 1995, Hughes & Petersen 2006), but until now, no gasteromycetes have been recorded as the host of *C. cirrata*. Furthermore, since only *Collybia tuberosa* and *C. cookei* have previously been known from Japan (Ito 1959), our collections also represent the first record of *C. cirrata* from Japanese mycobiota.

Materials and methods

The specimens examined in this study are deposited in the mycological herbarium of National Museum of Nature and Science, Tsukuba, Japan (TNS). Macroscopic characters were described by observations on dried or fresh materials. For light microscopic observations, free-hand sections of dried or fresh specimens were mounted in water, Melzer's reagent, 3% (w/v) KOH and 30% ethanol solution on glass slides. More than forty randomly selected basidiospores were measured under a light microscope at 1000× magnification. The surface features of basidiospores and capillitia of the host fungus were also observed by scanning electron microscopy (SEM). For SEM, small portion from the gleba were dusted onto double-sided adhesive tape on a specimen holder and coated with platinum-palladium using an E-1030 Ion Sputter Coater (Hitachi, Tokyo, Japan). They were examined with a S-4200 SEM (Hitachi, Tokyo, Japan) operating at 20 kV.

Taxonomy

Collybia cirrata (Schumach.) Quél.,

Mém. Soc. Émul. Montbéliard, Sér. 2, 5: 96 (1872), as "*cirrhatus*". Figures 1–2

≡ *Microcollybia cirrata* (Schumach.) Lennox, Mycotaxon 9: 193 (1979), as "*cirrhata*".

= *Collybia amanitae* (Batsch) Kreisel, Pilzfl. DDR, Basidiomyc.: 47 (1987), as "ined.", nom. inval. (Art. 34.1 (a)).

Pileus 1.5–8 mm diam., convex then plano-convex with slightly depressed center, finally irregularly concave, with almost straight margin, slightly hygrophanous, when moist white, cream to pale gray with slightly darker center, pallescent when drying, shining or dull, at margin sometimes slightly radially grooved, smooth, glabrous. Lamellae crowded, adnate, often slightly decurrent, white to cream, thin, with concolorous entire edge, 12–20 lamellae reaching stipe apex, 3–5 tiers of lamellulae. Stipe 10–15 × 1–1.5 mm, cylindrical or compressed, at apex white or pallid, downwards pale gray, yellowish brown or sometimes reddish brown, entirely pruinose or in upper part only and glabrous below, at base with radiating, white mycelial strands attached to the substratum, without forming a sclerotium. Context very thin, white. Smell indistinct. Spore print white.

Fig. 1. *Collybia cirrata* (from TNS-F-18606): A–B: Basidiomata associated with the mummified gleba of *B. dermoxantha*, C: *C. cirrata* in the natural habitat, a: basidiomata grows on the mummified gleba of *B. dermoxantha* (arrows), b: mature basidiomata of *B. dermoxantha*.

Bars: A–B = 5 mm; C = 10 mm.

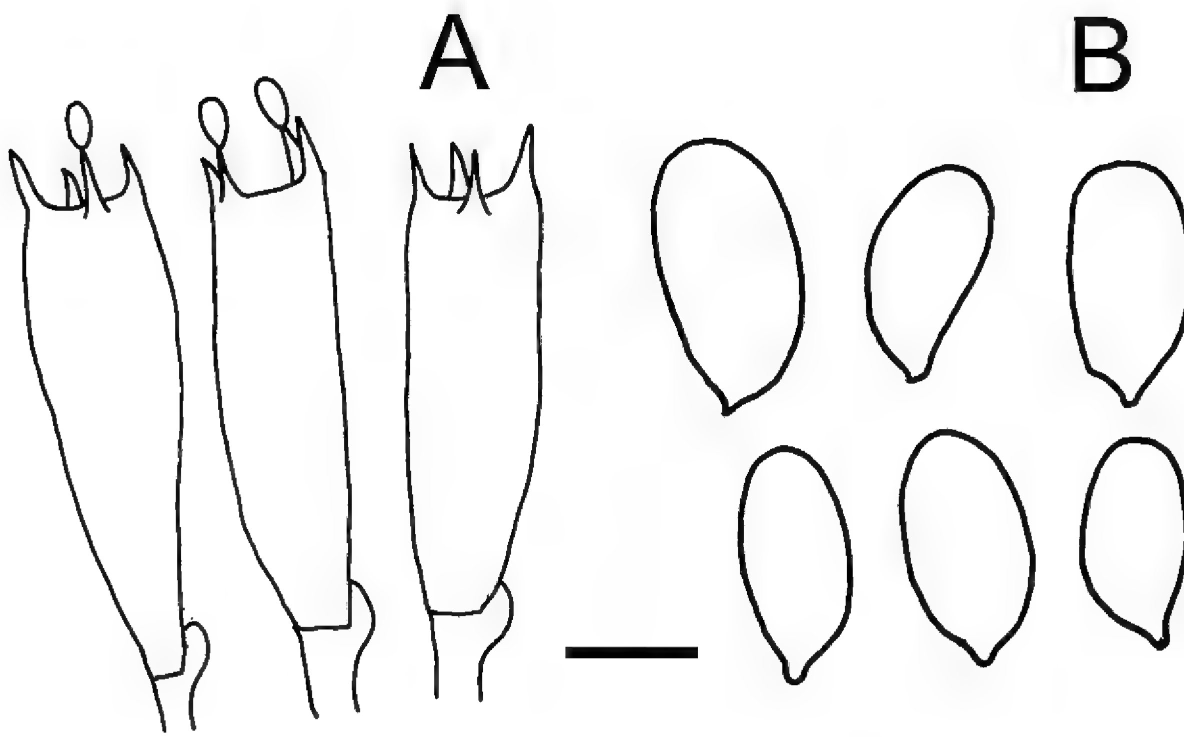

Fig. 2. *Collybia cirrata* (from TNS-F-18609): A: Basidia, B: basidiospores.
Bars: A = 5 µm; B = 2.5 µm.

Basidiospores 4.3–5.3 × 2.3–3 µm, Q = 1.3–2.1, ellipsoid to cylindrical, smooth, hyaline, thin-walled, nonamyloid. Basidia 15–22.5 ×3.5–5.5 µm, 4-spored, clavate. Lamella edge fertile. Hymenophoral trama subparallel, made up of 4–7.5 µm wide, cylindrical, thin-walled, hyaline hyphae. Pileipellis an ixocutis of cylindrical, 5–6.5 µm wide hyphae, with hyaline or pale yellowish walls, thin-walled, embedded in a 15–30 µm thick gelatinous hyaline matrix, with scattered erect, cylindrical, cystidioid terminal elements, 6–40 × 2–5.5 µm with thin, hyaline walls. Stipitipellis a cutis of 2–6 µm wide, cylindrical, pale yellow to yellowish brown hyphae. Caulocystidia 8–30 × 2–4.5 µm, cylindrical with rounded apex and curled base, towards base of stipe often up to 120 µm long, septate. Clamp-connections abundant in all tissues.

Habitat — Gregarious on the mummified gleba of *B. dermoxantha* in the open forest dominated by *Alnus crispa* subsp. *maximowiczii* (Callier) Hultén, *Betula ermanii* Cham. and *Salix bakko* Kimura of the subalpine and subarctic mountainous region.

Distribution — Japan (new record), Northern Eurasia (Hughes & Petersen 2006), Europe (Noordeloos 1995) and North America (Lennox 1979).

Japanese name — Hokori-yagura-take (newly named).

Specimens examined — **JAPAN. Hokkaido,** Kamikawa Province, Kamikawa-cho, Daisetuzan volcanic group, Ginsendai, alt. on 1535 m, 25 September 2006, S. Sato (TNS-F-18606); same locality, 18 September 2007, S. Sato (TNS-F-18609).

Discussion

The size of the basidiospores of the Japanese specimens deviate slightly from those reported for Europe (4.5–7 × 3–3.5 µm, Noordeloos 1995) and North America (5–7.5 × 2.5–3.5 µm, Lennox 1979). However, all other morphological characteristics of the Japanese specimens agree fully with previous descriptions of *Collybia cirrata* (Lennox 1979, Noordeloos 1995, Antonín & Noordeloos 1997). The presence of a sclerotium clearly distinguishes the other two species of the genus — *C. tuberosa* and *C. cookei* — from *C. cirrata* (Noordeloos 1995, Antonín & Noordeloos 1997, Hughes et al. 2001, Hughes & Petersen 2006).

We identified the host fungus of Japanese specimens as *Bovista dermoxantha*, which is a common representative of the *Lycoperdaceae* in Japan (Kasuya 2004a, b), based on morphological observations of capillitia and basidiospores (Fig. 3). This is the first report of fructification of *C. cirrata* on mummified gleba of lycoperdaceous fungi.

Collybia cirrata has frequently been collected from temperate, boreal, and alpine/arctic habitats of Europe, northern Eurasia and North America (Hughes & Petersen 2006). The Japanese specimens were also collected from subalpine and subarctic, open deciduous forests in northern Japan. We therefore infer a circumboreal distribution for *C. cirrata*, but further investigations of similar habitats in Asia are needed to clarify the geographical distribution of this fungus.

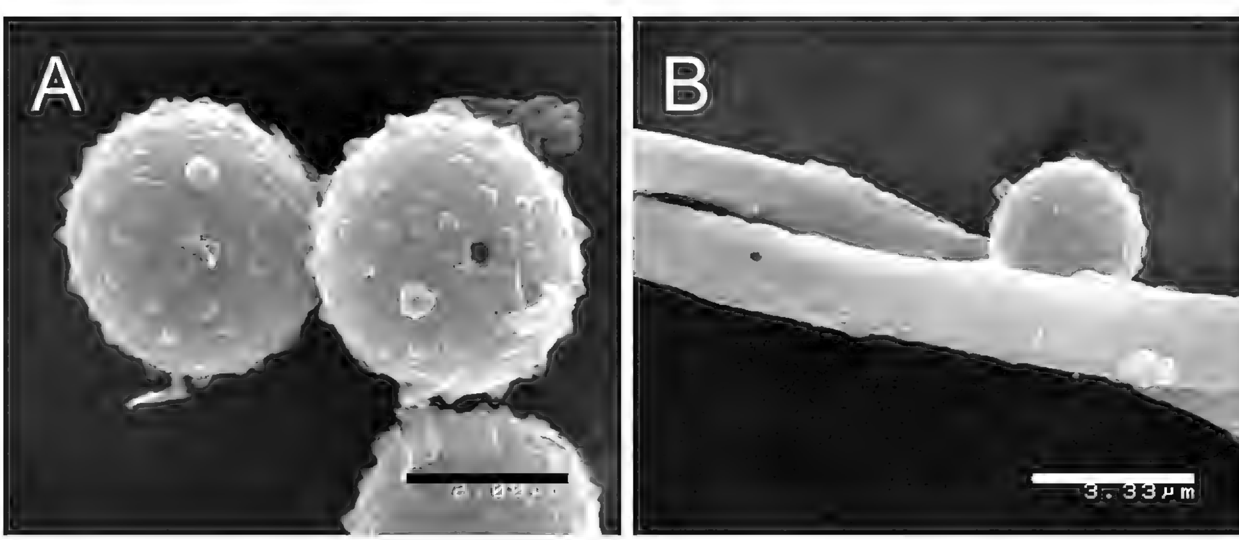

Fig. 3. *Bovista dermoxantha*, a host fungus of *C. cirrata* (from TNS-F-18606). SEM images. A: Basidiospores, B: Capillitia and a basidiospore. Bars: A = 2 µm; B = 3.33 µm.

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Four new species in the lichen genus *Diorygma*

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Abstract—Four new species of the genus *Diorygma*, with norstictic and salazinic acid as major compounds, namely *D. dealbatum, D. inaequale, D. manipurense* and *D. verrucirimosum* have been described from India. The occurrence of only norstictic and salazinic acid in combination is very rare in *Diorygma* and so far only one species of *Diorygma* containing norstictic and salazinic acids has been reported.

Keywords—lichenized fungi, ascomycetes, taxonomy, *Graphidaceae*

Introduction

In our recent survey of the lichen family *Graphidaceae* from India we have recorded the occurrence of several species in this family with hyaline, trans-septate ascospores (Adawadkar & Makhija 2004, 2006, 2007; Makhija & Adawadkar 2003, 2005a, b, 2007; Makhija et al. 2005, 2007). Currently we are undertaking studies on taxa with muriform ascospores in this family and we have found several species that can be placed in the lichen genus *Diorygma*.

Diorygma Eschw., a widely distributed, tropical to subtropical lichen genus with twenty-four species at the world level, was resurrected by Staiger (2002) and monographed by Kalb et al. (2004). Subsequently, five additional species have been described, viz. *D. nothofagi* (A.W. Archer) A.W. Archer, *D. wallamanense* A.W. Archer & Elix and *D. wilsonianum* (Müll. Arg.) A.W. Archer from Australia (Archer 2006, Archer & Elix 2008), *D. taliense* (A.W. Archer) A.W. Archer from the Solomon Islands (Archer 2007), and *D. alagoense* Cáceres & Lücking from Brazil (Cáceres 2007).

The genus *Diorygma* in India is so far known from five species (Kalb et al. 2004)—*D. hieroglyphicum* (Pers.) Staiger & Kalb, *D. junghuhnii* (Mont. & Bosch) Kalb et al., *D. megasporum* Kalb et al., *D. pruinosum* (Eschw.) Kalb et al. and *D. tuberculosum* (Stirt.) Kalb et al.

The lichen genus *Diorygma* is characterized by an inconspicuous pseudocortex, which results in a matte, often granular, farinose upper surface;

lirellate ascocarps with a heavily pruinose disc; branched, anastomosing paraphyses with a thick gelatinous wall (usually only the lumina are distinctly visible); paraphysis tips which are reticulately interwoven to form an epithecium; asci of the *Graphis*-type; ascospores hyaline, very rarely brownish, transversely septate with lenticular spore locules or muriform, and the presence of norstictic, stictic and/or protocetraric acid chemosyndromes (Kalb et al. 2004).

The occurrence of norstictic and salazinic acids in combination has been reported to be very rare in *Diorygma* and *D. salvadoriense* Kalb et al. is the only previously known species having norstictic and salazinic acids (Kalb et al. 2004).

During our investigations on *Diorygma* from India we have encountered four new species with hyaline, muriform ascospores and norstictic and salazinic acids as major compounds; these are described below.

Materials & methods

Chemical data was obtained by the standard method of TLC (Culberson & Kristinsson 1970, White & James 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-ethyl ether-formic acid (130:80:20) and toluene-ethyl acetate-formic acid (139:83:8). The specimens have been deposited in the Ajrekar Mycological Herbarium (AMH).

Key to the Indian species of *Diorygma* with norstictic and salazinic acids

1a. Exciple striate, ascospores 2–4/ascus
Thallus brownish white, rough; ascocarps 0.2–0.3 mm long mostly simple to rarely branched; disc brown, 0.4–0.5 mm broad; exciple 2–5 striate, apically dark brown; ascospores muriform, 76–92 × 21–25 µm. . . . . ***D. manipurense***

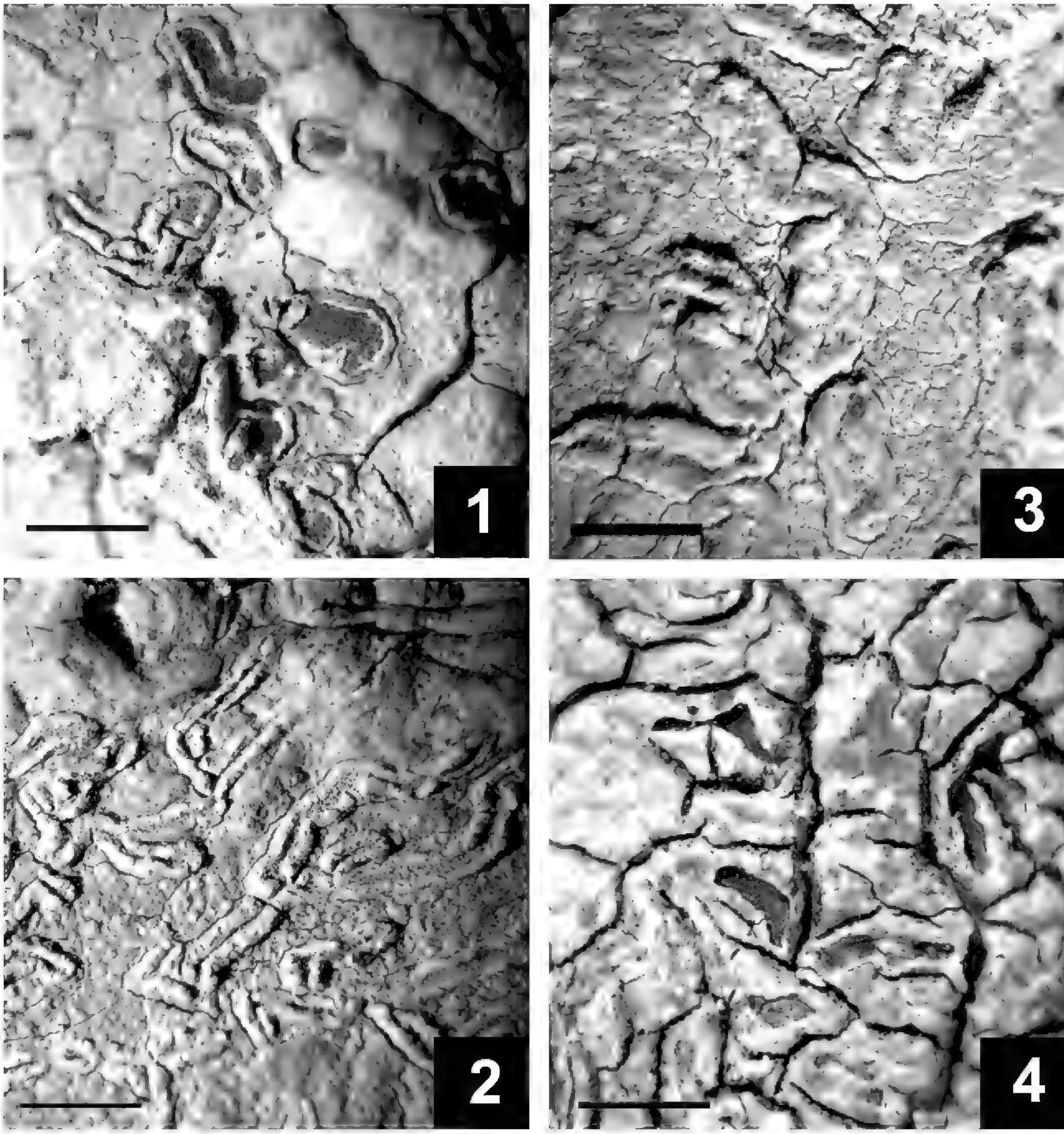
1b. Exciple not striate, ascospores 1/ascus 2

2a. Ascospores less than 100 µm long.
Thallus glaucous green, uneven, partly with tubercules; ascocarps 1–6 mm long, simple to irregularly branched; disc brown, 0.2–0.3 mm broad; exciple non-striate; ascospores muriform, 79–96 × 29–33 µm . . . . ***D. inaequale***

2b. Ascospores exceeding 100 µm long 3

3a. Thallus deeply cracked and strongly verrucose.
Ascocarps crowded, short, 1–2 mm long; disc narrow to broad, sunken, reddish brown, 0.2–0.4 mm broad; exciple non-striate; ascospores muriform, 97–126 × 25–33 µm . . . . ***D. verrucirimosum***

3b. Thallus not verrucose.
Thallus white with brown tinge, smooth; ascocarps close to each other, simple to branched, 0.5–2.5 mm long; disc brown to blackish brown, 0.2–0.7 mm broad; exciple non-striate; ascospores muriform, 105–147×33–37 µm . . . .***D. dealbatum***



FIGURES 1–4. Habit (Holotypes)
Diorygma dealbatum, D. inaequale, D. manipurense, D. verrucirimosum.
Bar = 1 mm

Diorygma dealbatum B.O. Sharma & Makhija, **sp. nov.** FIGURE 1

MYCOBANK MB 512483

Similis Diorygma salvadoreinse, *sed ascosporis minoribus et loculis aequalis. Similis* Diorygma tibelii, *sed ascis 1-sporis, ascosporis majoribus et acida norsticticum et salazinicum continens differt.*

ETYMOLOGY: from the latin *dealbatus*; white upon a darker ground, a reference to thallus colous.

Holotypus—India, Tamil Nadu, Chitteri, 15.10.1985, *M.B. Nagarkar & P.G. Patwardhan, 85.1408*: AMH.

Thallus corticolous, white with brown tinge, smooth, thick, finely cracked, with a thin pseudocortex. Ascocarps rounded, lirellate, concolorous with the thallus, immersed, irregular, simple to branched, curved, 0.5–2.5 mm long, ends round, thalline margin slightly raised. Disc narrow to broad, 0.2–0.7 mm wide, brown to blackish brown, covered with a white pruina. Exciple divergent, uncarbonized, laterally poorly developed, base distinctly orange brown, broken at the base forming a canal like structure, merging into the thallus. Epithecium distinct, blackish brown. Hymenium hyaline, not inspersed, I+ blue, 125–150 µm high. Paraphyses anastomosing. Ascospores 1/ascus, hyaline, muriform, I+ blue, peripheral and central spore locules of equal size, 105–147 × 33–37 µm.

Chemistry—Norstictic and salazinic acids present.

Additional specimens examined—Tamil Nadu, Kollimalai, *M.B. Nagarkar & P.G. Patwardhan,* 85.1516, 85.1571:AMH.

Remarks—*Diorygma dealbatum* differs from *D. salvadoriense* Kalb et al. in having slightly smaller ascospores with the peripheral locules equal to the central ones. *D. salvadoriense* has large ascospores of 150–200(–230) × 50–75 µm. with the peripheral locules distinctly smaller than the central ones.

Diorygma dealbatum is somewhat similar to *Diorygma tibellii* Kalb, et al. in fine cracks, occurring especially along the lirellae, ascocarp size and morphology but differs from *D. tibellii* in having 1-spored asci and norstictic and salazinic acids. *D. tibellii* has 2–4 spored asci, smaller ascospores (55–90×(16–)20–30 µm), and stictic, peristictic, substictic, constictic and cryptostictic acids. Under *D. tibellii,* Kalb et al. (2004) reported one collection from Ecuador containing salazinic acid.

Diorygma dealbatum can easily be differentiated from *D. verrucirimosum* (vide infra) in not having a deeply cracked and verrucose thallus.

This new species was collected in northern Tamil Nadu state of India at an altitude of about 900 m where the climate is generally cooler and wetter than the surrounding plains.

Diorygma inaequale B.O. Sharma & Makhija, **sp. nov.** Figure 2

MycoBank MB 512455

Similis Diorygma erythrellum, *sed ascosporis majoribus et acida norsticticum et salazinicum continens differt.*

Etymology: From the latin *inaequale*, unequal, a reference to the nature of the uneven thallus.

Holotypus—India, West Bengal, 2 km to Sevak on Gauhati road, northern bank of Mahanadi, above bridge, 23.10.1977, *P.G. Patwardhan & M.B. Nagarkar, 77.641*: AMH.

Thallus corticolous, glaucous green with a yellow and or red tinge, cracked, uneven, partly with tubercules; thin pseudocortex visible, delimited by a black hypothallus. Ascocarps 1–6 mm long, ends acute to obtuse, flexuous, simple to

irregularly branched, margin distinctly raised. Disc more or less open, 0.2–0.3 mm wide, brown, covered with white pruina in young ascocarps. Exciple non-striate, divergent, non carbonized, distinctly orange at the base. Hymenium hyaline, 100–112.5 µm high, not inspersed, I+ blue. Epithecium distinctly developed, brown, consisting of brownish reticulately branched paraphysis tips. Paraphyses anastomosing. Ascospores 1/ascus, hyaline, muriform, I+ blue violet, peripheral and central spore locules of equal size, 79–96×29.4–33.6 µm.

Chemistry—Norstictic and salazinic acids present.

Remarks—The new species *Diorygma inaequale* is closely related to the South-East Asian species *D. erythrellum* (Mont. & Boasch) Kalb et al. in respect of external morphology in having an uneven thallus with small warts, and the size of the ascocarps (0.7–7 mm long). *D. erythrellum*, however, differs from *D. inaequale* in having 8 ascospores per ascus, which are smaller (30–65×12–20 µm), and a chemistry with norstictic (major), connorstictic (minor or trace) and stictic acids.

Diorygma tuberculosum, a species from Nilgiri hills of India, exhibits a similar external morphology with *D. inaequale* but differs in having slightly smaller ascospores with all spore locules of equal size and in chemistry. *D. tuberculosum* has larger ascospores (100–130×44–48 µm), with the peripheral spore locules distinctly smaller than the central ones and with norstictic and connorstictic acids but no salazinic acid.

Diorygma inaequale differs from *D. manipurense* (vide infra), a species with same ascospore size, by its entire, non striate exciple, and 1 ascospore per ascus compared to 2–4 ascospores per ascus in *D. manipurense.*

The species was collected from semi-evergreen forests at high–altitudes in Kerala, Tamil Nadu and West Bengal, where the climate is generally comparatively cooler.

Additional specimens examined—Kerala, Wayanad forest, *S.P. Kekre & P.K. Sethy*, 81.749; on the way to Valparai, *P.K. Sethy & P.G. Patwardhan*, 82.253. Tamil Nadu, Yercaud, *P.G. Patwardhan & M.B. Nagarkar*, 85.1354. West Bengal, 2 km to Sevak on Gauhati road, northern bank of Mahanadi above bridge, *P.G. Patwardhan & M.B. Nagarkar*, 77.642, 77.653-AMH

Diorygma manipurense B.O. Sharma & Makhija, **sp. nov.** Figure 3

MycoBank MB 512484

Similis Diorygma salvadoriense, *sed ascis 2–4 sporis, et ascosporis minoribus differt.*

Etymology: from the Latin *ensis,* a place of origin, and Manipur, the type locality.

Holotypus—India, Manipur State, Near Mao, 1 km from Mao on Imphal road in ravine, 8.11.1977, *P.G. Patwardhan & M.B. Nagarkar, 77.1510*: AMH.

Thallus corticolous, brownish white, ± smooth to rough, uneven, delimited by a distinct, thin blackish hypothallus. Ascocarps concolorous with the thallus,

lirellate, narrow, flattened, immersed, irregular, curved, more or less flexuouse, 0.2–0.3 mm long, ends obtuse, mostly simple to rarely branched, thalline margin raised. Disc narrow to distinctly open, 0.4–0.5 mm wide, brown, white pruinose. Exciple convergent to divergent, with 2–5 thin striae, apically dark brown, colourless at the base. Hymenium hyaline, 130–150 µm high, not inspersed, I+blue. Epithecium brownish, consisting of reticulately branched, hyaline or brownish paraphyses tips. Paraphyses anastomosing. Ascospores 2–4/ascus, hyaline, muriform, I+blue violet, peripheral and central spore locules of equal size, 76–92 × 21–25 µm.

Chemistry—Norstictic and salazinic acids present.

Remarks—*Diorygma manipurense* is distinguished from *D. salvadoriense*, a species also containing norstictic and salazinic acids, by its non flaking thallus, and 2–4/ascus, smaller ascospores (76–92×21–25 µm). *D. salvadoriense* has flaking thallus, and 1/ascus, much larger ascospores (150–200(–230)×50–75 µm).

Diorygma megasporum, which also has a striate exciple and is known from India, has different characters and does not contain salazinic acid.

Diorygma manipurense is so far known from the type locality Mao in the Manipur State of India and was collected at about 1788 m altitude from the evergreen forest.

Diorygma verrucirimosum B.O. Sharma & Makhija, **sp. nov.** Figure 4

MycoBank MB 512485

Similis Diorygma circumfusum, *sed ascosporis muriformis differt.*

Etymology: from the latin *verruca,* wart, and *rimosus*, with numerous cracks, a reference to the nature of thallus

Holotypus—India, Tamil Nadu, Yercaud, 13.10.1985, *M.B. Nagarkar & P.G. Patwardhan, 85.1368*: AMH.

Thallus corticolous, glaucous grey, deeply cracked, distinctly verrucose, margin of the thallus white, hypothallus not distinct. Ascocarps crowded, concolorous with the thallus, irregular, flexuous, curved, immersed, short, 1–2 mm long, ends acute to obtuse, thalline margin slightly raised. Disc narrow to wide, sunken, 0.2–0.4 mm wide, reddish brown covered with white pruina. Exciple covered by crystals, divergent, uncarbonized, base distinctly orange brown. Epithecium distinct, brown to hyaline. Hymenium hyaline, not inspersed, I+ blue, 123–150 µm high. Paraphyses anastomosing. Ascospores 1/ascus, hyaline, muriform, I+ blue, peripheral and central spore locules of equal size, 97–126×25–33 µm.

Chemistry—Norstictic and salazinic acids present.

Additional specimens examined—Tamil Nadu, Yercaud, *M.B. Nagarkar & P.G. Patwardhan,* 85.1369, 85.1388, 85.1824-AMH

Remarks—*Diorygma verrucirimosum* differs from the other species of *Diorygma* described in the present paper by its deeply cracked and verrucose thallus. *Diorygma circumfusum* (Stirt.) Kalb et al. also has thallus with many fine or deeper cracks, especially along the lirellae similar to *D. verrucirimosum* but *D. circumfusum* differs from the new species in having transversely septate ascospores and a different chemistry.

The species was collected from Yercaud situated in the Shevaroy Hills of Tamil Nadu State of India at an altitude of about 1500 m from the semievergreen forest.

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Fungi of Cameroon 1. New corticioid species (*Basidiomycetes*)

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Abstract — Three new species of corticioid fungi *Phlebiopsis bicornis*, *Schizopora crassihypha* and *Steccherinum dimiticum* from the Mbalmayo Forest Reserve, Cameroon, are described, illustrated in detail and discussed.

Key words — resupinate fungi, systematics, novelties, tropical Africa

Introduction

Previous taxonomic studies on the Cameroon mycota have indicated a high diversity of aphyllophoroid fungi, especially species belonging to the group of corticioid fungi (Berthet & Boidin 1966, Boidin & Lanquetin 1973, Hjortstam et al. 1993, Roberts 2000, Roberts & Ryvarden 2006, Douanla-Meli 2007). The number of species of this group reported from Cameroon is less than 80 (Roberts 2000), thus many species await description. The study of macrofungal collections from the Mbalmayo Forest Reserve (MFR) has added several additional new reports of corticioid species for Cameroon (Douanla-Meli 2007). In this paper three new species are proposed based on the above-mentioned collections.

Materials and methods

The specimens examined were collected during three field trips in the MFR. The data relating to the ecology and environment of the site can be found in Douanla-Meli (2007). Microscopic features were studied from free-hand thin sections mounted in 5% KOH, Melzer's solution (MR+ = amyloid, MR– = nonamyloid). Observation and measurement were carried out at 1000× with bright field and phase contrast optics in light microscope (Olympus BX51TF). For SEM photographs, dried basidiospores were collected on platinum stubs and gold-coated to a thickness of 20 nm with a Balzers SCD 020 Coating Unit (Balzers, Liechtenstein), and then examined at 10 kV with a Hitachi S 4000 Scanning Electron Microscope. 30 randomly selected basidiospores were measured for each collection. Length-to-width ratios are noted as E, with Q

the arithmetic mean of E. Colour terms in parentheses are those of Kornerup & Wanscher (1978). Type materials are deposited at the herbarium of the University of Yaoundé I, Cameroon (HUYI) with isotype in O. Herbaria are cited according to Holmgren et al. (1990).

Phlebiopsis bicornis Douanla-Meli, **sp. nov.** FIG. 1

MycoBank MB 512486

Differt ab P. gigantea *et* P. roumeguerei *basidia bisterigmatica; Basidiosporae 4.5–7 × 3–4.5 µm, variabilis figurae, late ellipsoideae, paene oviformae vel paene nucleiformae.*

Holotypus: *Cameroon, Dept. Nyong & So'o, MFR, Oyack II, 04.X.2002, DMC 518 in HUYI, Isotypus in O.*

Etymology—referring to the bisterigmate basidia.

Basidiomata annual to perennial, resupinate, effused and often large, thin, in section up to 0.5 mm thick, ceraceous in the living state, and membranaceous-crustaceous when dry, whitish, pale yellowish (2A3) to cream (4A3), usually adnate but loosening from the substrata along the margins when dry; hymenial surface apparently smooth to the naked eye and somewhat tuberculose with scarce cracks under the hand lens, and velutinous owing to the numerous projecting metuloids; margins whitish, lighter than the centre part, thinning out, fimbriate to more or less fibrillose-determinate.

Hyphal system monomitic; generative hyphae 2–5 µm diam., without clamps, subhymenium thickening, not distinctly stratified, with strongly intricate, agglutinated hyphae and a high density of metuloid cystidia, hence the coriaceous to ceraceous texture; hyphae mostly thin- to slightly thick-walled; subiculum absent to hardly noticeable. Cystidia as numerous metuloids, (30–)40–100 × 12–18 µm, protruding up to 50 µm beyond the basidia, upper conical part richly encrusted with a crystalline coat up to two-fifths of the total length (but crystals lacking on some immersed cystidia), lower part cylindrical to ventricose, naked, walls up to 5 µm thick, hyaline to pale greenish yellowish (1A8). Basidia 15–23 × 4–5 µm, forming with numerous basidioles a densely agglutinated palisade, apically dilated, 2(–4)-spored, with 4-spored basidia very scarce, sterigmata at first stout becoming 2–5 µm long and undulate to arcuate, slightly projecting. Basidiospores 4.5–8 × 3–4.5 µm, E = 1.42–1.64, Q = 1.52, variable in shape, narrowly ellipsoid, pip-shaped, subovate, with adaxial side straight or somewhat concave, smooth, thin-walled and MR–.

Habitat and known distribution—On dead hardwood in lowland to premontane forest dominated by *Sterculiaceae* and *Ulmaceae*. So far only known from the type locality, MFR, Cameroon.

Comment—*Phlebiopsis bicornis* is characterized by its smooth to tuberculose, ceraceous, yellowish to cream basidiomata, abundant and large metuloid

FIGURE 1. *Phlebiopsis bicornis* (Holotype DMC 518).
a. Section through the basidiomata. b. Encrusted metuloid cystidia. c. Basidia. d. Basidiospores.
Scale bar = 10 µm for b and 5 µm for a, c and d.

cystidia and agglutinated clampless hyphae. Within the genus, *P. bicornis* is morphologically related to *P. gigantea* (Fr.) Jülich and *P. roumeguerei* (Bres.) Jülich & Stalpers. Both species are European in distribution, have richly encrusted cystidia 60–90 µm long, and have oblong to narrow ellipsoid basidiospores of similar size range [(4.5–6(–8) × 2.5–3 µm and 4–5(–6) × 2.5–3 (–3.5) µm respectively]. They are separated by the subiculum texture, which is well developed in *P. gigantea* and scanty or lacking in *P. roumeguerei* (Eriksson et al. 1981). Two apparently similar Cameroon collections from Korup National Park, Watling 22788 and K(M) 64665 (not examined in this study) described as *Phlebiopsis* sp. (Hjortstam et al. 1993, Roberts 2000), are characterized by shorter, 30 × 10 µm, metuloid cystidia and smaller, 5 × 2.5 µm basidiospores, which suggest they are closely related to *P. galochroa* (Bres.) Hjortstam & Ryvarden. Another species closely related to *P. bicornis* is the pantropical *P. ravenelii* (Cooke) Hjortstam, which is also similar to *P. flavidoalba* (Cooke) Hjortstam. Both species were originally described from North America, but *P. flavidoalba* also has a neotropical distribution, and larger basidiospores [6.5–7(–7.5) × 3.5–3.75 µm] of *P. flavidoalba* help to distinguish it from *P. ravenelii* with smaller basidiospores (5–5.25 × 3.75–4 µm).

Steccherícium dimiticum Douanla-Meli, **sp. nov.** FIGS. 2–3

MYCOBANK MB 512487

Differt ab St. seriatum *systemate hypharum dimitico; Gloeocystidia parva, (15–)20–60 × 5–9 µm, clavata vel cylindrica, saepe pseudoseptata, tenuitunicata vel crassitunicata.*

Holotypus: *Cameroon, Dept. Nyong & So'o, MFR, Ekombitie, 16.X.2002, DMC 410 in HUYI, Isotypus in O.*

ETYMOLOGY—referring to the dimitic hyphal system.

BASIDIOMATA annual, resupinate, effused-reflexed to subpileate, sessile and broadly attached; pileus semicircular, dimidiate, imbricate with lateral pilei fused, up to 6 cm long, up to 2.5 cm wide and 1–2.5 mm thick at the base; consistency tough to hard when dry; upper surface at first brownish (6D5) to orange-white (5A2), becoming greyish white (-B1) to cream (4A3) and mostly yellowish brown (5E8) towards the base when dry, adpressed tomentose, weakly concentrically sulcate, azonate; margins on effused parts thin, acute, fimbriate and always incurved when dry, rhizomorphs absent; hymenium odontioid to hydnoid, yellowish white (2A2) to cream (4A3), aculei crowded, 4–5 per mm, conical, 1–2 mm long, not fimbriate; subiculum or context soft corky, whitish to yellowish white (2A2), tough, up to 0.5 mm thick.

HYPHAL SYSTEM dimitic and tending to trimitic; generative hyphae clamped, hyaline, 1–2.5 µm diam., thin-walled and much branched in the subhymenium, 2.5–3 µm diam., thin- to slightly thick-walled, frequently branched and often with sprouting clamps in the aculeal trama, subiculum and context; skeletal hyphae 2.5–4 µm diam., thick-walled with large lumen, in the aculeal trama often with oily contents, hyaline, not dextrinoid, some branched and thickened hyphae resembling binding hyphae present in the context. CYSTIDIA absent. GLOEOCYSTIDIA numerous, variable in shape and size, 35–60 × 5–9 µm, cylindrical, straight to slightly flexuous, thin-walled, with short curved base, embedded in the subhymenial layer, projecting into the hymenium but rarely protruding; (15–)30–50 × 5–9 µm, clavate, club-shape to subcylindrical, thin to slightly thick-walled at the tubular to cylindrical end, at the base often curved and long-stalked (stalk 20–60 µm long up to the basal clamp), many with a few adventitious septa, contents oily, compact to finely granular, at times delimitating an obtuse to mucronate non-oily apex, embedded in the context and aculei trama. BASIDIA 12–15 × 3–4 µm, clavate to subcylindrical, 2–4-spored, sterigmata short and spine-like, with a basal clamp. BASIDIOSPORES 3–4 × 2.5–3 µm, E = 1.18–1.32, Q = 1.25, ellipsoid to oblong, hyaline, thin-walled, finely punctate and MR++.

HABITAT AND KNOWN DISTRIBUTION—On dead hardwood in lowland to premontane forest dominated by *Sterculiaceae* and *Ulmaceae*. So far only known from the type locality, MFR, Cameroon.

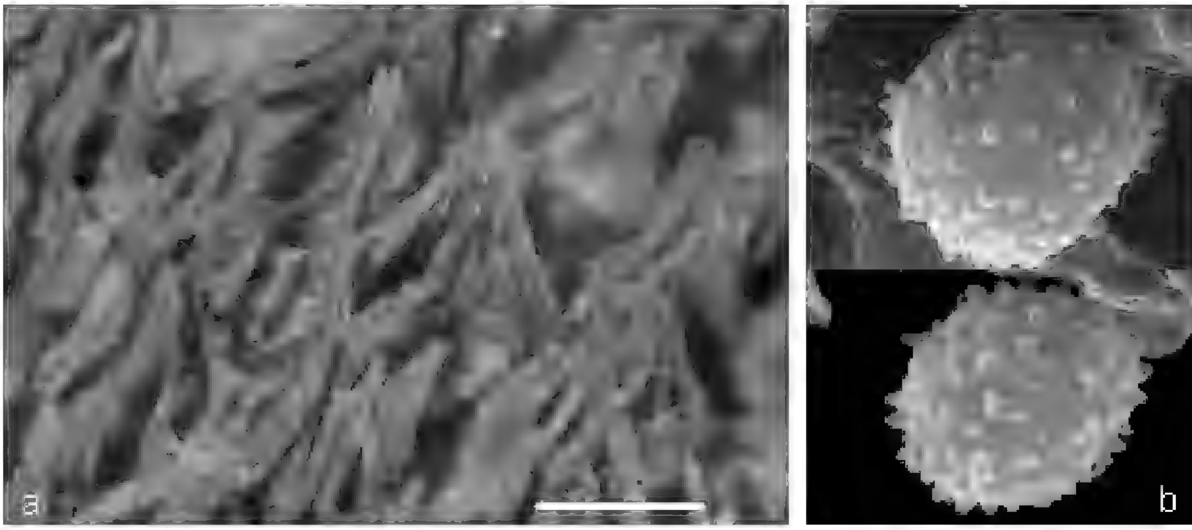

FIGURE 2. *Steccherícium dimiticum* (Holotype DMC 410).
a. Odontioid to hydnoid hymenial surface. b. SEM micrograph of basidiospores.
Scale bar = 2 mm for a and 2 µm for b.

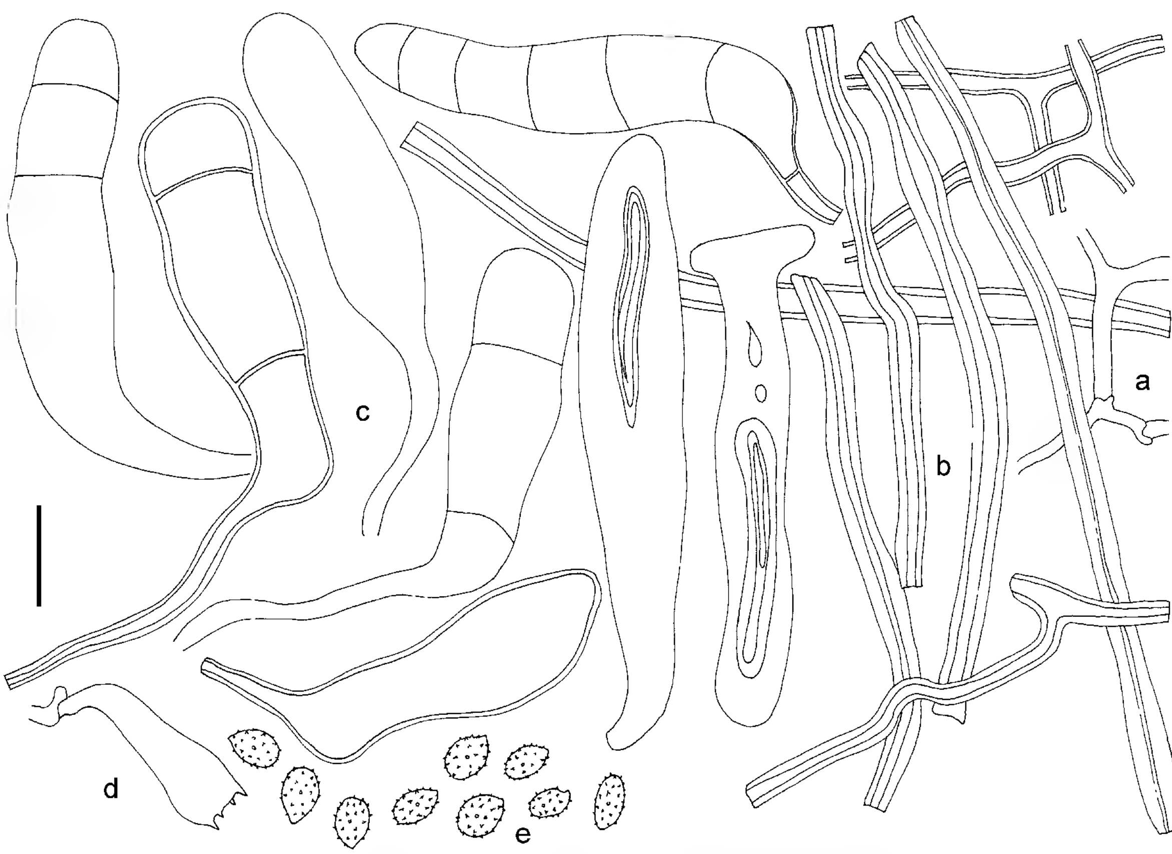

FIGURE 3. *Steccherícium dimiticum* (Holotype DMC 410).
a. Generative hyphae. b. Skeletal hyphae. c. Gloeocystidia. d. Basidia. e. Basidiospores.
Scale bar = 10 µm for a-d and 5 µm for e.

ADDITIONAL SPECIMEN EXAMINED—CAMEROON. Centre Province, Dept. Nyong & So'o, MFR, Ekombitie, 47 km South east of Yaounde, 11° 54′ E, 3° 58′ N, alt. 500–650 m, 16.X.2002, DMC 411 in HUYI.

COMMENT—*Steccherícium dimiticum* is characterized by the pale basidiomata with odontioid (DMC 411) to hydnoid (DMC 410) hymenial surface, dimitic hyphal system, and gloeocystidia that have oily contents and are often

secondarily septate. A number of poroid species with a dimitic to trimitic hyphal system originally placed in *Steccherícium* D.A. Reid by Corner (1989) have been synonymized with *Wrightoporia* Pouzar (Stalpers 1996, Hattori 2003). This indicates the overlapping features between the two genera, such as the amyloid and ornamented basidiospores. Although species of *Wrightoporia* are dimitic, they are distinctly poroid, have dextrinoid tramal skeletal hyphae, and infrequently possess gloeocystidia (Gilbertson & Ryvarden 1987, Hattori 2003, Dai & Cui 2006). Despite its dimitic hyphal system, the new species is keyed out in *Steccherícium* on account of its odontioid hymenial surface. Among the five valid species in this genus (Index Fungorum 2004), *St. seriatum* (Lloyd) Maas Geest. is closely related to *St. dimiticum*. *St. seriatum* is characterized by the dull orange basidiomata, tubular gloeocystidia 50–100 µm long without adventitious septa, and ellipsoid to oblong, 3.5–4 × 2.5–3 µm basidiospores (Roberts 2000). Moreover, *St. seriatum* is typically monomitic, thus the combination of shorter and pseudoseptate gloeocystidia, and dimitic to trimitic hyphal system delimits *St. dimiticum*.

Schizopora crassihypha Douanla-Meli, **sp. nov.** FIG. 4

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Basidiomata annua, resupinata; consistentia coriacea; superficies hymenialis porifera vel radiato-fibrillosa. Systema hypharum dimitica. Hyphae generativae ramosae, fibulatae, tenuitunicatae vel crassitunicatae, hyphae sceleticae crassitunicatae. Basidiosporae 3–4 × 2.3–3 µm, paene globosae vel ellipsoidae.

***Holotypus**: Cameroon, Dept. Nyong & So'o, MFR, Oyack II, 24.IX.2002 DMC 519 in HUYI, Isotypus in O.*

ETYMOLOGY—referring to the constantly thick-walled, generative hyphae.

BASIDIOMATA annual, resupinate, thin, membranous, 100–250 µm thick, adnate, extensive, continuous but with intercalary depressions hollowed out of irregular areas; consistency coriaceous to hard when dry; hymenial surface poroid to rimose toward margin, whitish yellow (2A2) to cream (4A3); margin more or less fibrillose, whitish to yellowish white (2A2), without rhizomorphs; pores 5–7 per mm, mostly elongated up to 1 mm, often lacerate-denticulate; tubes concolorous, very shallow, up to 150 µm deep; context or subiculum fibrous, up to 100 µm thick, yellowish (2A3).

HYPHAL SYSTEM dimitic; generative hyphae 3–5 µm diam., clamped, hyaline, moderately thickened in subhymenium to distinctly thick-walled in subiculum, in subhymenium richly branched in acute to right angles with short segments, some hyphae covered with fine crystalline material; skeletal hyphae 3.5–6 µm diam., dominating in the subiculum, dense and perpendicularly arranged, straight or sinuous, hyaline, thick-walled, walls thinning toward the apices; few hyphal ends on the edges of dissepiments encrusted with fine granular crystals.

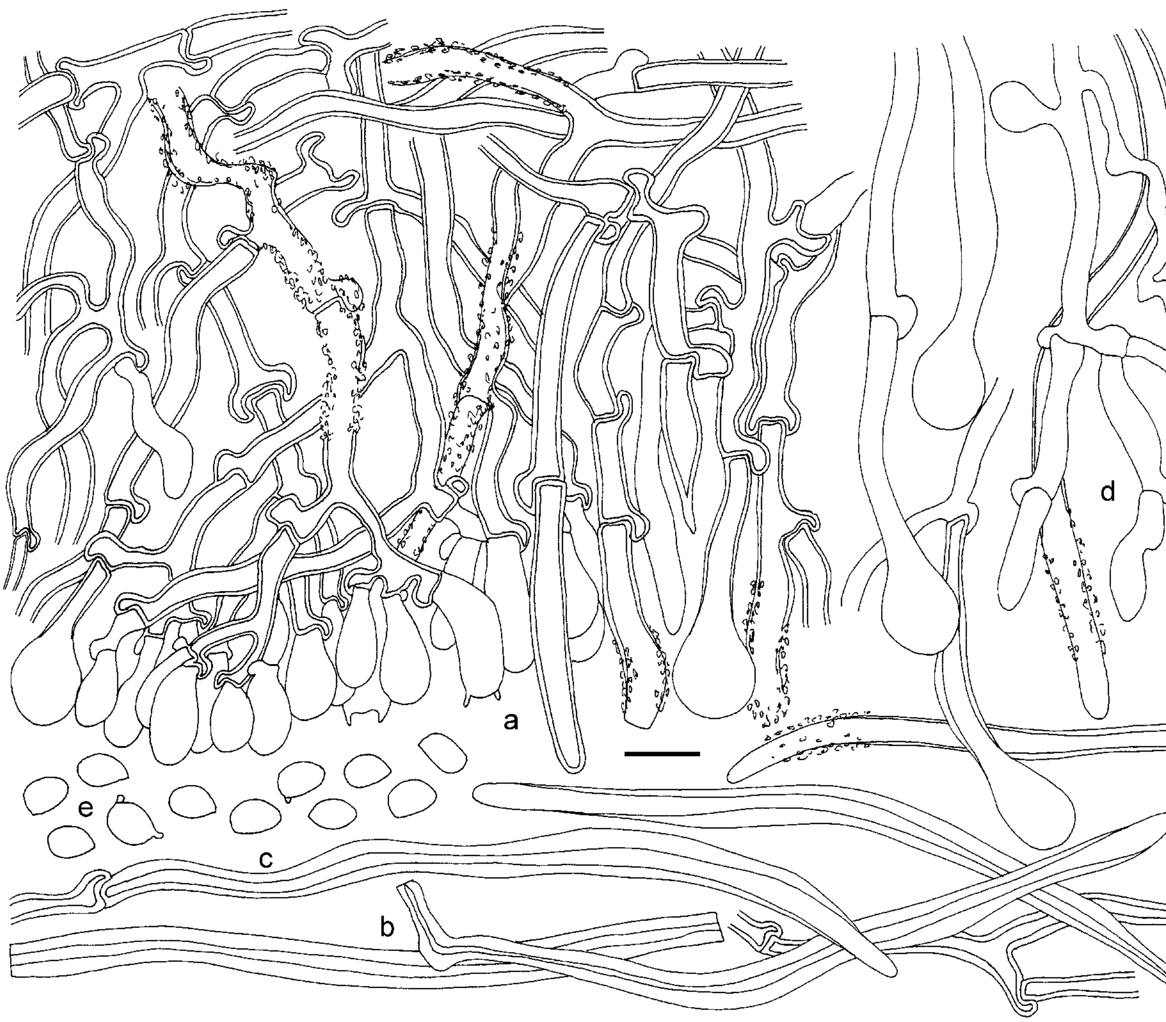

Figure 4. *Schizopora crassihypha* (Holotype DMC 519).
a. Section through the basidiomata. b. Tramal thick-walled skeletal hyphae.
c. Tramal thick-walled generative hyphae. d. Capitate cystidioid elements. e. Basidiospores.
Scale bar = 5 µm.

Cystidioid elements numerous as capitate hyphal ends in the hymenium and edges of dissepiments, 20–30 long, provided with a rounded cap 7–10 µm broad, lacking resinous apical material, slightly thick- to thick-walled on the narrow basal part and thin-walled upward or entirely thick-walled, not encrusted; fusiform cystidia present, 19–22 × 4–4.5 µm, ventricose toward the base and gradually effilate upward. Basidia (7–)12–16 × 4.5–6 µm, 2-spored, subcylindrical, clavate to suburniform, with a basal clamp. Basidiospores 3–4 × 2.3–3 µm, subglobose to broadly ellipsoid, hyaline, thin-walled, smooth and MR–, many basidiospores with either one or both ends strangulated into conspicuous papillae reminiscent of conidial formation, though no conidia were observed.

Habitat and known distribution—On dead wood and bark of sapeli, *Entandrophragma cylindricum* (Sprague) Sprague, in lowland to premontane forest dominated by *Sterculiaceae* and *Ulmaceae*. So far only known from the type locality, MFR, Cameroon.

Comment—The tough and poroid basidiomata, almost thick-walled generative hyphae and cystidioid elements consisting of inflated hyphal ends characterize *Schizopora crassihypha*. Some generic features like capitate cystidia with globular encrustation and suburniform basidia are lacking in *S. crassihypha*. Nevertheless the poroid hymenial surface and inflated or encrusted hyphal ends strongly suggest its placement in *Schizopora*. *Hyphodontia* J. Erikss. and *Schizopora* show significant morphological convergence and appear in a paraphyletic assemblage (Langer 1994, Binder et al. 2005). *Hyphodontia* species are basically monomitic, however, even the few poroid species (Wu 2000, 2001).

Among the seven valid *Schizopora* species (Index Fungorum 2004), the commonest species, *S. paradoxa* (Schrad.) Donk, is a close relative of *S. crassihypha*. *S. paradoxa* shows considerable variations in hymenial surface pattern, basidiospore size, and frequency of capitate cystidioles, which are linked to its geographical distribution (Ryvarden & Johansen 1980, Eriksson et al. 1984, Gilbertson & Ryvarden 1987, Quanten 1997, Douanla-Meli 2007). *S. paradoxa* shares with *S. flavipora* (Berk. & M.A. Curtis ex Cooke) Ryvarden relatively shallow pores, often splitting and becoming irpicoid to labyrinthine. In both cases the generative hyphae are typically thin to slightly thick-walled, always thin-walled in the subhymenium. Basidiospores are 3.5–5 × 2.5–3.5 µm in *S. flavipora* and rather broader, 4–6(–6.5) × 3.5–4 µm, in *S. paradoxa* (Eriksson et al. 1984, Douanla-Meli 2007).

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The genus *Lepiota* (*Agaricales, Basidiomycota*) in Kerala State, India

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Abstract — Twenty-two taxa belonging to the agaric genus *Lepiota* are documented from Kerala State, India, including full descriptions and illustrations of eight new species and one new variety (*L. ananya*, *L. anupama*, *L. babruka*, *L. babruzalka*, *L. harithaka*, *L. nirupama*, *L. shveta*, *L. zalkavritha*, *L. brevipes* var. *distincta*). Of the eleven species that are new records for India, *Lepiota subincarnata*, *L. brevipes*, *L. elaiophylla*, *L. ianthinosquamosa* and *L. murinocapitata* are also reported for the first time from Asia. A key to the species of *Lepiota* in Kerala is given.

Key words — *Agaricaceae*, floristics, new taxa

Introduction

Formerly, agaricologists adopted a wide genus-concept of *Lepiota* (Pers.) Gray (*Agaricales*, *Basidiomycota*) that embraced all white-spored species of *Agaricaceae* with a scaly pileus, free lamellae, an annulus, and smooth dextrinoid spores. Enhanced understanding of the macro- and microcharacters, however, resulted in narrower generic concepts such as those held by Singer (1986) and Bon (1996). These new restricted genus-concepts pruned *Lepiota* sensu lato by removing taxa to smaller and segregate genera like *Cystolepiota* Singer, *Leucoagaricus* Locq. ex Singer, *Leucocoprinus* Pat., and *Macrolepiota* Singer based on more reliable differentiating characters. In this paper, we follow such a restricted concept of the genus.

Lepiota sensu stricto is relatively well known from the temperate regions of the world. However, lepiotas remain to be properly documented for most of the tropics. Manjula (1983) listed about 37 species (except for several synonyms and excluded species) of *Lepiota* sensu stricto recorded from India to which another 17 species have been subsequently added (Natarajan et al. 2005). Only three *Lepiota* species have been recorded so far from Kerala State, a geographical area that includes a major part of the Western Ghats of Peninsular India and which is recognized as one of the biodiversity hotspots of the world. These include

Lepiota guatopoensis Dennis (Vrinda et al. 2001), *Lepiota pyrrhaes* (Berk. & Broome) Sacc. (Vrinda et al. 1999), and *Lepiota viriditincta* (Manimohan et al. 1988). During our preliminary studies on the lepiotaceous fungi of Kerala, we encountered 22 *Lepiota* taxa including eight new species and one new variety. The new taxa are fully described and illustrated and others are documented below.

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. Colour codes refer to Kornerup & Wanscher (1978). Holotypes of all new taxa and additional and/or representative collections of all taxa documented here are deposited at Kew Herbarium and these collections are indicated by their Kew accession numbers. All other examined collections cited are in the personal herbarium of the second author.

Taxonomic account

Key to the *Lepiota* species of Kerala

1a. Spores not spurred 2
1b. Spores spurred 5

2a. Spores large, fusoid .... ***L. metulispora***
2b. Spores small to medium-sized, not fusoid 3

3a. Pileus covering with pyramidal squamules, composed of chains of inflated, cylindrical or ellipsoid to globose terminal elements 7
3b. Pileus covering without pyramidal squamules, composed of ascending or erect clavate, cylindrical, fusoid, lageniform or ventricose terminal elements 4

4a. Clamp connections occasional to frequent 9
4b. Clamp connections absent 20

5a. Pileal covering with olive brown squamules; spores 6.5–9 × 3–4 µm .... ***L. griseovirens***
5b. Pileal covering with brown or brownish orange squamules 6

6a. Spores 6–9.5 × 3–4 µm; elements of pileal covering without encrusting pigment .... ***L. erythrosticta***
6b. Spores 9–12 × 3.5–4.5 µm; elements of pileal covering with encrusting pigment .... ***L. castanea***

7a. Pileus light orange with brown squamules; lamellae light orange; context light orange; cheilocystidia and pleurocystidia absent; spores 4–6 × 2–3 µm .... ***L. pseudoasperula***

7b. Pileus light brown, reddish brown or dark brown; lamellae white to yellowish white; context white to yellowish white; cheilocystidia present but pleurocystidia absent 8

8a. Cheilocystidia inflated-clavate, sphaeropedunculate or pedicellate-ovoid; clamp connections absent; spores 4.5–7 × 3–4 µm . . . . ***L. babruka***

8b. Cheilocystidia clavate, utriform, cylindrical, pyriform, ellipsoid or ovoid; clamp connections present, but rare; spores 4–6 × 3 µm . . . . ***L. nirupama***

9a. Pileal covering made of long fusoid, or flexuose elements 10

9b. Pileal covering not made of long fusoid, or flexuose elements but with clavate, cylindrical or ellipsoid elements 15

10a. Lamellae and context white to yellowish white; spore lengths range from 4.5 to 7.5µm 11

10b. Lamellae and context pastel-yellow; spore lengths range from 6 to 9 µm 14

11a. Pileal surface orange-white with cinnamon-brown squamules; elements of pileal covering up to 300 µm long; spores 4.5–7.5 × 3–5 µm . . . . . ***L. subincarnata***

11b. Pileal surface whitish or yellowish white with brown to reddish brown squamules; elements of pileal covering less than 200 µm long. 12

12a. Pileus 19–27 mm diameter; stipe turning brownish orange on bruising; cheilocystidia septate and occasionally with apical excrescences; spores 4.5–6 × 3–4.5 µm . . . . ***L. zalkavritha***

12b. Pileus 4–17 mm diameter; stipe not exhibiting colour change on bruising; cheilocystidia aseptate;. 13

13a. Pileal background yellowish white, pale yellow/cream, without a rosy tinge; cheilocystidia thin-walled and without any encrustations; spores 4.5–7 × 2.5–4 µm . . . . ***L. brevipes*** var. ***brevipes***

13b. Pileal background white, with a rosy tinge; cheilocystidia slightly thick- to thick-walled and with encrustations; spores 4–5 × 3 µm. . . ***L. brevipes*** var. ***distincta***

14a. Pileal covering made of long fusoid or clavate elements intermixed with a layer of smaller, invariably clavate elements; cheilocystidia cylindrical, clavate or utriform; spores 6–8 × 3–4.5 µm . . . .***L. xanthophylla***

14b. Pileal covering made up entirely of cylindrical or fusoid elements; cheilocystidia never utriform; spores 6–9 × 3–4.5 µm . . . .***L. elaiophylla***

15a. Basidiomata medium-sized; pileus more than 40 mm diameter; annulus with a dark grey squamulose rim; spores 6–9 × 3–4(–5) µm, lacrymoid to subcylindric, with a strong suprahilar depression; clamp connections abundant . . . . ***L. ianthinosquamosa***

15b. Basidiomata small; pileus less than 25 mm diameter; annulus without a coloured rim; spores oblong, ellipsoid, subcylindrical or amygdaliform without any distinct suprahilar depression; clamp connections rare 16

16a. Basidiomata turn bluish green on bruising; spores 7–10 × 4–5 µm ***L. viriditincta***

16b. Basidiomata do not turn bluish green on bruising. 17

17a. Pileus striate; stipe covering a cutis of repent hyphae 18
17b. Pileus non-striate; stipe covering a disrupted cutis with ascending hyphal elements 19

18a. Pileus whitish with brownish grey to reddish grey squamules; lamellae white; spores 5–7 × 3.5–5 µm, oblong-ellipsoid to broadly ellipsoid; pileal elements without encrusting pigment...................... ***L. anupama***
18b. Pileus whitish with dark brown squamules; lamellae yellowish; spores 5.5–8 × 3.5–4.5 µm, amygdaliform; pileal elements with encrusting pigment .... ***L. ananya***

19a. Basidiomata dull white with reddish brown squamules; cheilocystidia versiform; pileal elements with encrusting pigment; spores 5.5–10.5 × 3.5–4.5 µm .... ***L. babruzalka***
19b. Basidiomata entirely white; cheilocystidia clavate to cylindrico-clavate; pileal elements without encrusting pigment; spores 6–9.5 × 3.5–5 µm.... ***L. shveta***

20a. Basidiomata turning greyish green on bruising; terminal elements of pileal covering with encrusting pigment; spores 5–7 × 3–4 µm........... ***L. harithaka***
20b. Basidiomata not turning greyish green on bruising; terminal elements of pileal covering lacking encrusting pigment 21

21a. Pileus more than 15 mm diameter, white with brownish grey squamules; annulus fugacious; spores 5–8 × 3.5–5 µm, ellipsoid to oblong-ellipsoid .... ***L. plumbicolor***
21b. Pileus less than 10 mm diameter, dark grey; annulus persistent; spores 4.5–6 × 3.5–4.5 µm, subamygdaliform .... ***L. murinocapitata***

Lepiota metulispora (Berk. & Broome) Sacc., Syll. Fung. 5: 38 (1887)

Collections examined — **INDIA, Kerala State, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 28 June 2006, Arun Kumar *AK401* (*K(M)157144*); 7 July 2006, Arun Kumar *AK414*; 7 August 2006, Arun Kumar *AK414a*.

Discussion: Except for the presence of crowded cheilocystidia, the Kerala collections have characteristics that readily agree with the description of *L. metulispora* from Sri Lanka (Pegler 1972, 1986). This species has already been reported from India (Natarajan & Manjula 1983, Manjula 1983). *Lepiota magnispora* Murrill, is a very closely related species that mainly differs by having a yellowish or pinkish veil, a non-striate pileal margin, and a more fleshy and robust basidioma. In addition, the dark brown fibrillose scales on the pileus as well as the dark brown spiral bands towards the stipe base are differentiating features of that species.

Lepiota griseovirens Maire, Bull. trimes. Soc. mycol. France 44: 37 (1928)

Collections examined — **INDIA, Kerala State, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 9 August 2004, Arun Kumar *AK86* (*K(M)157135*); 10 August

2004, Arun Kumar *AK86a* (*K(M)157136*); 12 August 2004, Arun Kumar *AK86b*; 13 August 2004, Arun Kumar *AK86c*; 16 August 2004, Arun Kumar *AK86d*; 17 August 2004, Arun Kumar *AK90;* 15 October 2004, Arun Kumar *AK135;* 9 November 2004, Arun Kumar *AK178;* 30 June 2005, Arun Kumar *AK325;* 15 October 2006, Arun Kumar *AK458.*

Discussion: *Lepiota griseovirens* is characterized by a pileus with some shades of green, olive, or blue on a yellowish white background and dark grey to olive-brown squamules, especially at the centre. The Kerala collections are in close agreement with the descriptions of the species given by Candusso & Lanzoni (1990), Vellinga & Huijser (1993), Breitenbach & Kränzlin (1995), Bon (1996) and Vellinga (2001b), except for minor variations in basidial and cystidial dimensions. This is the first report of this species from India. A related species, *Lepiota grangei* (Eyre) Kühner resembles *L. griseovirens* in gross morphology as evident from a color photograph of that species from Switzerland (Breitenbach & Kränzlin, 1995), but could be separated based on its distinctly larger spores and mostly septate elements (normally with up to three clampless septa) of pileal covering with fine pigment encrustation. *Lepiota poliochloodes* Vellinga & Huijser, another greenish member of the genus, differs in having lighter pileal squamules, slightly smaller spores and clavate pileal end-cells. *Lepiota pilodes* Vellinga & Huijser differs mainly by its broad cheilocystidia and thin-layered pileal elements at the disc.

Lepiota erythrosticta (Berk. & Broome) Sacc., Syll. Fung. 5: 62 (1887)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 10 November 2003, Arun Kumar AK11 (K(M)157137); 5 October 2004, Arun Kumar AK119 (K(M)157138); 7 October 2004, Arun Kumar AK119a; 5 October 2004, Arun Kumar AK122; 9 November 2004, Arun Kumar AK175; 10 November 2004, Arun Kumar AK175a; 24 July 2006, Arun Kumar AK119b; 18 July 2006, Arun Kumar AK418; 27 September 2006, Arun Kumar AK449.

Discussion: This species has basidiomata covered with bright reddish brown squamules that give it a striking appearance. It is characterized by yellowish white lamellae; spores with an abaxial protraction; crowded, cylindric, clavate, or utriform cheilocystidia; and erect, cylindrico-clavate to subfusoid terminal elements with brown plasmatic pigment in the pileal covering.

The Kerala collections agree with the description of this species by Pegler (1972, 1986), but differ by the lack of a distinct lilaceous or vinaceous tint on the pileal surface. Dennis (1952) recorded smaller spores (5–6 × 3 µm) from the material from Trinidad. This is the first record of this species from India.

Lepiota castanea Quél., C.R. Ass. Franç. Av. Sci. 9: 661 (1881)

Collections examined — INDIA, Kerala State, Idukki District, MUNNAR: 9 June 2006, Arun Kumar AK392 (K(M)157123); 10 June 2006, Arun Kumar AK392a.

Discussion: The present collections agree well with the description of this species given by Vellinga (2001b) except that the septations of the pileal elements are not well developed. *Lepiota castanea* is a highly variable species displaying a wide range in macro and micromorphologic characters. This species is common in Europe, North America and in temperate Asia. Interestingly, collections of this species made from Kerala were from Munnar where cooler climatic conditions prevail owing to the high altitude. This is the first report of this species from India.

Lepiota pseudoasperula (Knudsen) Knudsen, Bot. Tidsskr. 75: 128 (1980)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 October 2004, Arun Kumar AK145 (K(M)157124); 1 November 2004, Arun Kumar AK145a; 2 November 2004, Arun Kumar AK162; 4 November 2004, Arun Kumar AK162a; 5 November 2004, Arun Kumar AK173; 10 November 2004, Arun Kumar AK145b.

Discussion: Knudsen originally described this species under the genus *Cystolepiota* but subsequently, he transferred it to *Lepiota* (Knudsen 1980). The slight variations noticed in the Kerala collections from the earlier descriptions (Knudsen 1978, 1980; Candusso & Lanzoni 1990, Vellinga 2001a) are the appendiculate pileal margin (margin recorded as 'even' in Knudsen 1978) and the slightly smaller dimensions of the pileal elements. Knudsen (1978, 1980) mentioned that the spore-print was never seen and Vellinga (2001a) assumed it to be probably white. During the present study, spore-print colour was found to be white. The Kerala collections represent the first record of this species from Asia.

Lepiota babruka T.K.A. Kumar & Manim., **sp. nov.** Figure 1

MycoBank MB511877

Pileus 30 mm latus, convexus, applanato expansus, umbonatus, brunneus, squamulis atrobrunneus obtectus. Lamellae liberae, albidae dein pallide luteae, confertae. Stipes 35 × 2 mm, brunneus dein atrobrunneus, fibrillosus. Sporae 4.5–7 × 3–4 µm, ovo-ellipsoideae vel oblongo-ellipsoideae, hyalinae, exiliter dextrinoideae. Basidia 10–17 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 13–34 × 10–20 µm, versiforma, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes fibulatae.

Holotype — INDIA, Kerala State, Kannur District, NEELIYARKOTTAM: 16 October 2004, Arun Kumar AK139 (K(M)155991 HOLOTYPE).

Etymology: *babruka* (Sanskrit), brownish

Basidioma somewhat medium-sized. Pileus 30 mm diam., broadly convex, becoming applanate, with a broad indistinct umbo; surface brown (6E6), with dark brown (6F8) squamules; squamules pyramidal at the disc, appressed and radiating towards the edge; margin incurved, becoming straight, eroded and

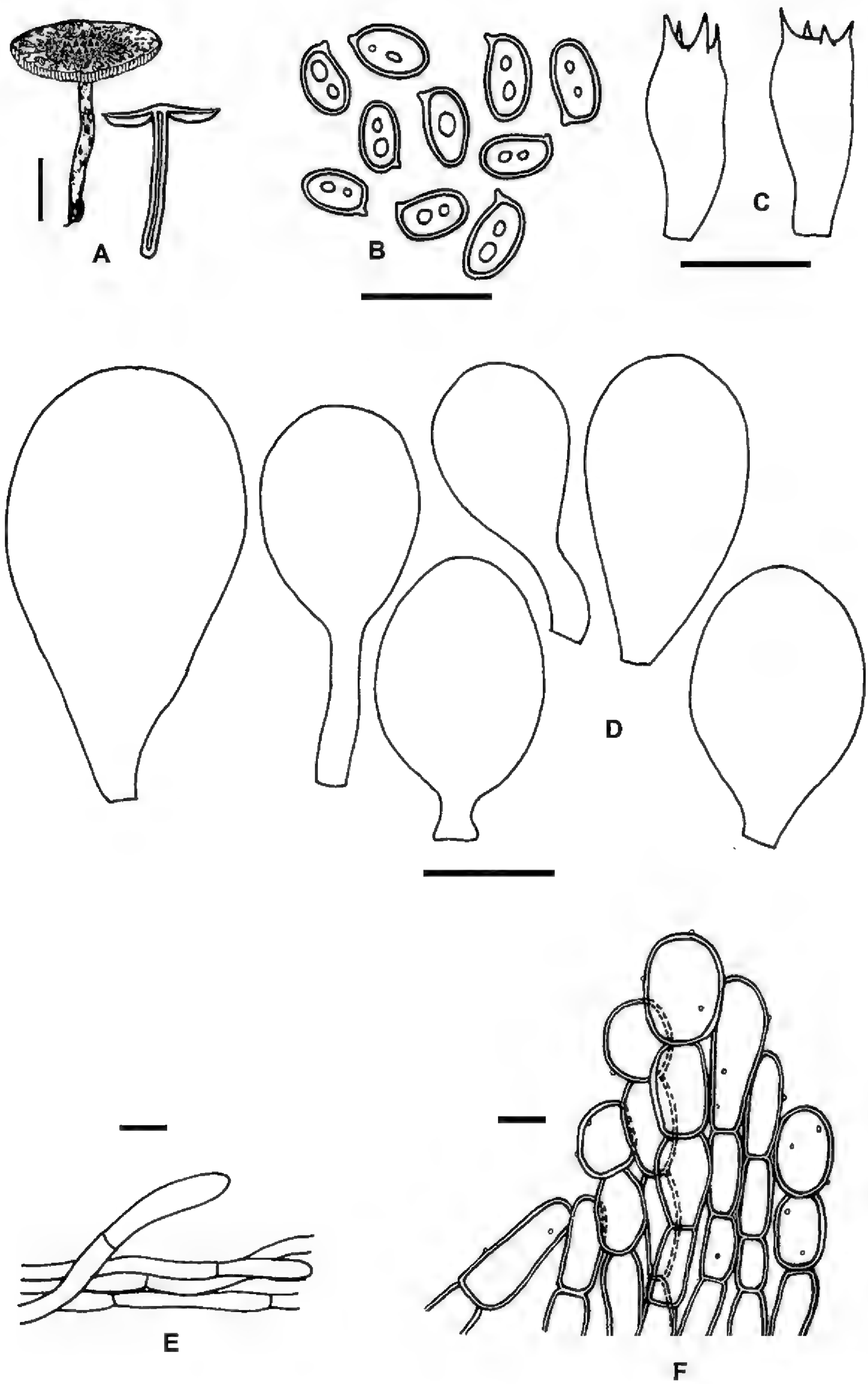

FIGURE 1. *Lepiota babruka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

fissile with age. LAMELLAE free, initially white, turning yellowish white (4A2) to pale yellow (4A3), crowded, up to 5 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 35 × 2 mm, central, terete, equal, fistulose; surface brown (6E6) becoming dark brown (6F8) with age, fibrillose; base arising from white mycelium. ANNULUS superior, fibrillose, evanescent, whitish. CONTEXT less than 2 mm thick, yellowish white (4A2). ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 4.5–7 × 3–4 (6.2 ± 0.8 × 3.6 ± 0.4) µm, Q = 1.25–1.8, Qm = 1.6, ovo-ellipsoid to oblong-ellipsoid, hyaline, with refractive guttules, thick-walled, smooth, weakly dextrinoid, non-metachromatic, cyanophilic. BASIDIA 10–17 × 6–8 µm, cylindrico-clavate to clavate, hyaline, bearing 4 sterigmata up to 3 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 13–34 × 10–20 µm, inflated-clavate, sphaeropedunculate or pedicellate-ovoid, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–21 µm wide, inflated, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–10 µm wide, often inflated up to 20 µm wide, hyaline, thin-walled, septate, inamyloid. PILEAL COVERING a disrupted cutis of filamentous hyphae, 3–15 µm wide, with transitions to trichodermial patches of erect hyphal bundles terminated by chains of short end cells; almost entirely trichodermial at the centre with agglutinated conical bundles reaching up to 500 µm in length; terminal cells 12–47 × 6–18 µm, cylindrical, ellipsoid, subglobose or clavate, thin- to slightly thick-walled with brown to dark brown plasmatic and membrane pigments. STIPE COVERING a cutis of repent, 2–10 µm wide, hyaline to pale yellowish brown hyphae with a few ascending terminal elements; terminal elements 20–32 × 5–9 µm, cylindrical, thin-walled, hyaline to pale yellow. All hyphae devoid of clamp connections.

HABITAT: On soil among decaying leaf litter, solitary.

DISCUSSION: This species is characterized by pyramidal squamules on the pileus, ovo-ellipsoid to oblong-ellipsoid spores, vesicular cheilocystidia, agglutinated chains of versiform end-cells in the pileal covering, and hyphae devoid of clamp connections.

The present collection resembles species of *Lepiota* section *Echinatae* Fayod although affinities with the genus *Cystolepiota* in the nature of pileal covering and in the weakly dextrinoid spores are evident. According to Vellinga (2001a) a velar structure with 'thin hyphae gradually transient into globose to ellipsoid elements, agglutinated to form pyramidal squamules' is characteristic of *Lepiota* section *Echinatae*. Following this observation, the present species is better placed in the genus *Lepiota*. However, this species remains distinct by virtue of its fibrillose fugacious annulus, weakly dextrinoid spores and clampless hyphae and does not match with any of the previously described species under

Lepiota or *Cystolepiota*. *Lepiota efibulis* Knudsen is a related species in *Lepiota* section *Echinatae* that also lacks clamp connections (Knudsen 1980, Vellinga 2001b), but that species differs from the present collection in having a distinct membranous annulus and much smaller spores that are metachromatic in cresyl blue.

Lepiota nirupama T.K.A. Kumar & Manim., **sp. nov.** FIGURE 2

MycoBank MB511878

Pileus 20–30 mm latus, primo subglobosus, postea convexus, pallide brunneus, rubro-brunneus vel atrobrunneus, squamulis verrusis ad discum confertioribus obtectus, obscure fibrillosus, non striatus. Lamellae liberae, albae, confertae. Stipes 32–40 × 2–5 mm, pallide brunneus vel rubro-brunneus, squamulis superficialis obtectus. Sporae 4–6 × 3 µm, ellipsoideae, hyalinae, dextrinoideae. Basidia 15–20 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 12–25 × 5–7 µm, clavata vel utriformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.

HOLOTYPE: INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK352 (K(M)155992 HOLOTYPE).

ETYMOLOGY: *nirupama* (Sanskrit), unequalled

BASIDIOMATA small. PILEUS 20–30 mm diam., initially subglobose, gradually parabolic or conico-convex and finally convex; surface light brown (7D5) to reddish brown (8E6) or dark brown (7F8), with abundant warty to conical, concolorous, detersile squamules, which upon detachment leaves a darker reticulate pattern on a lighter pileal background, more concentrated towards the disc and sparser towards the margin, finely fibrillose, non-striate; pellis peeling off as a layer from the margin on maturity exposing the context; margin initially incurved, later straight, eroded. LAMELLAE free, white, moderately crowded to crowded, up to 7 mm wide, with lamellulae in 4–5 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 32–40 × 2–5 mm, central, terete, almost equal, fistulose, becoming hollow with age; surface light brown (7F8) to reddish brown (8E6), with scattered pyramidal superficial squamules, whitish above the annulus and when young, minutely fibrillose; base arising from white mycelium. ANNULUS superior, membranous-fibrillose, ascending, movable, whitish, densely covered with whitish to light brown (7D5) floccose squamules on the lower side. CONTEXT up to 6 mm thick, white. ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 4–6 × 3 (5 ± 0.44 × 3 ± 0) µm, Q = 1.3–2, Qm = 1.6, ellipsoid, some with a slight hunch, hyaline, with refractive guttules, thin- to slightly thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 15–20 × 6–8 µm, cylindrico-clavate to clavate, with guttulate contents, hyaline, bearing 4 sterigmata up to 2 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 12–25 × 5–7 µm, clavate or utriform with a pedicel, thin-walled,

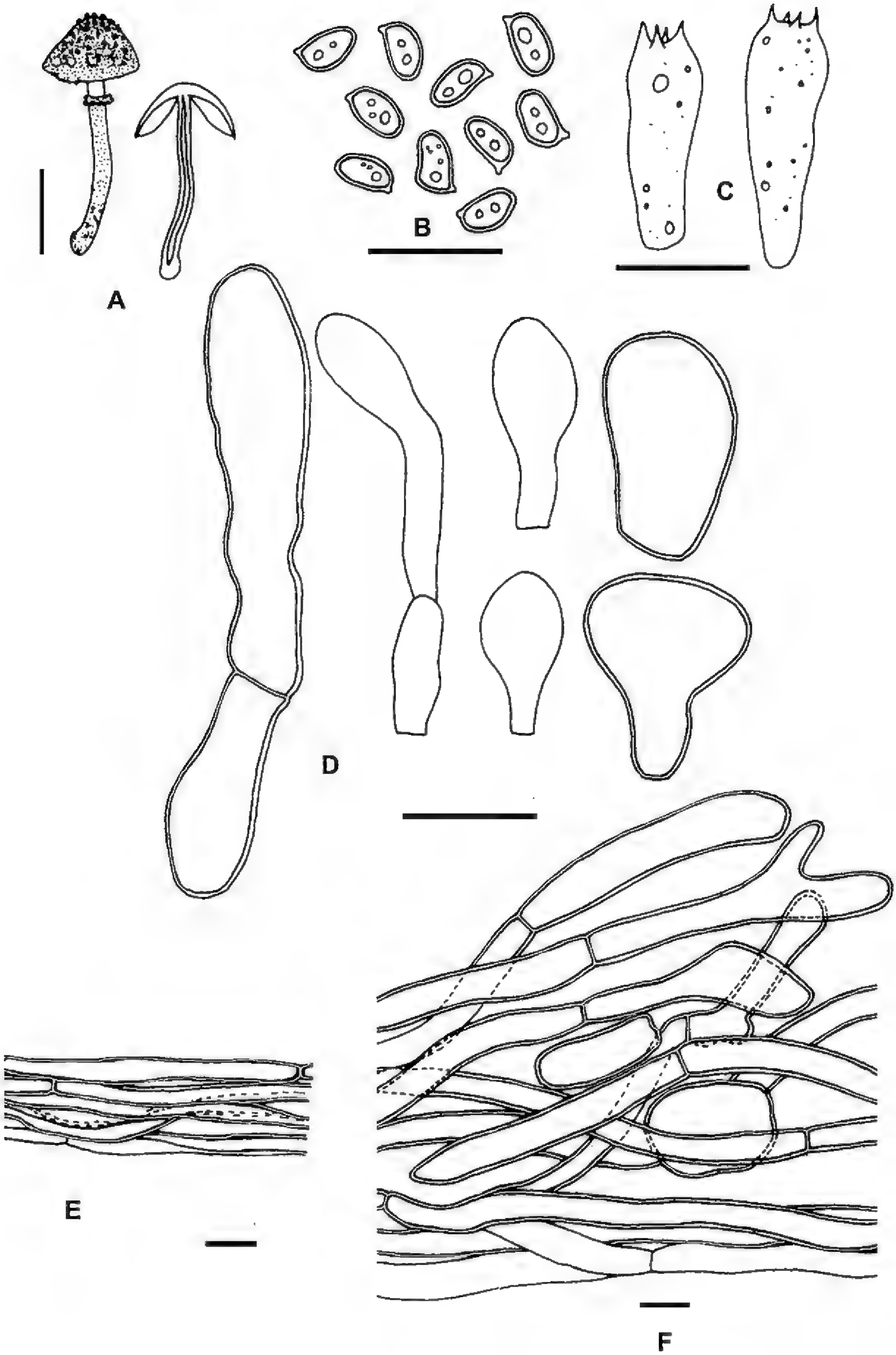

Figure 2. *Lepiota nirupama*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

hyaline, interspersed by relatively few, inflated, loosely attached, slightly thick-walled (up to 0.5 µm), hyaline, cylindrical, clavate, pyriform, utriform, ellipsoid or ovoid cells, 10–34 × 7–20 µm. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–12 µm wide, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–15 µm wide, cylindrical, hyaline to pale yellow, thin-walled, inamyloid. PILEAL COVERING a highly disrupted cutis of 2–17 µm wide hyphae with trichodermial patches of ascending or erect, loosely attached, branched and thick-walled (up to 1 µm) hyphal elements with brown to dark brownish plasmatic and membrane pigments; terminal elements 17–70 × 4–17 µm, cylindrical, ellipsoid, oblong or ovoid. STIPE COVERING a cutis of repent, filamentous, 2–13 µm wide, thin- to slightly thick-walled (up to 1 µm) hyphae with hyaline to pale grey plasmatic pigments, disrupted to form occasional trichodermial transitions at the scales with loosely attached, erect or ascending cylindrical, clavate or ovoid elements that are slightly thick-walled and with pale yellow to brownish plasmatic and wall pigments. clamp connections rarely observed.

HABITAT: On soil and decaying leaf litter, solitary or scattered in groups.

ADDITIONAL COLLECTIONS EXAMINED — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 18 July 2005, Arun Kumar AK353 (K(M)157131); 20 July 2005, Arun Kumar AK366.

DISCUSSION: *Lepiota nirupama* is a distinct species of the section *Echinatae,* characterized by ellipsoid and dextrinoid spores; crowded cheilocystidia interspersed with inflated and slightly thick-walled versiform cells; and a pileal covering with loosely attached cylindrical, ellipsoid, oblong or ovoid terminal elements. It has distinctive reddish brown to dark brown pyramidal superficial squamules and a prominent ascending annulus densely covered with whitish to light brown floccose squamules. Combination of characteristics of the present material does not match any published descriptions.

Lepiota subincarnata J.E. Lange, Fl. Agaric. Danic. 5(Append.): V (1940)

COLLECTIONS EXAMINED — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 29 August 2003, Arun Kumar AK2 (K(M)157125); 11 November 2003, Arun Kumar AK2a (K(M)157126); 23 July 2004, Arun Kumar AK78; 25 July 2004, Arun Kumar AK78a; 4 October 2004, Arun Kumar AK118; 5 October 2004, Arun Kumar AK118a; 5 October 2004, Arun Kumar AK 120; 6 October 2004, Arun Kumar AK118b; 7 October 2004, Arun Kumar AK118c; 26 October 2004, Arun Kumar AK151; 29 September 2006, Arun Kumar AK452.

DISCUSSION: The material of this species from Kerala is in close agreement with the description of the species by Pegler (1977) and Vellinga (2001b). The present collections slightly differ from the earlier descriptions in having a basal layer of pileal elements made up of cylindrical to ventricose elements along with the fusiform elements. This species is distinguished by cinnamon-brown squamules

on a paler pileal background, oblong-ellipsoid spores, clavate cheilocystidia, and a pileal covering made up of mostly subfusiform elements up to 400 µm long. This combination of characteristics places this species under the section *Ovisporae* (J.E. Lange) Kühner. This report represents the first record of this species from India.

Lepiota zalkavritha T.K.A. Kumar & Manim., **sp. nov.** FIGURE 3

MycoBank MB511879

Pileus 19–27 mm latus, subglobosus vel convexus applanato expansus, umbonatus, albidus, squamulis brunneis granularis obtectus. Lamellae liberae, primo albidae, postea pallide luteae, confertae. Stipes 25–34 × 4–5 mm, ad basim bulbosus, albidus, vulneratae brunneo-aurantius, squamulis brunneis obtectus. Sporae 4.5–6 × 3–4.5 µm, ellipsoideae hyalinae, crassitunicatae, dextrinoideae. Basidia 20–25 × 6–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 12–32 × 5.5–10 µm, versiformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis. Epicutis pilei e vallo trichodermiate efformata, ex hyphis erectis composita. Hyphae omnes fibulatae.

HOLOTYPE: INDIA, Kerala State, Calicut District, PUTHIYANGADI: 24 September 2006, Arun Kumar AK442 (K(M)155999, HOLOTYPE).

ETYMOLOGY: *zalkavritha* (Sanskrit), covered with scales

BASIDIOMATA small but robust. PILEUS 19–27 mm diam., subglobose when young, becoming convex to broadly convex, finally applanate, slightly umbonate at the disc when young but umbo often becomes indistinct with maturity; surface entirely covered with light brown (6D4, 6D5) to brown (6E5), granular to appressed fibrillose squamules on a dull white background, areolate cracking towards the margin, pruinose to smooth at the disc; pileal covering peels off as a layer from the margin exposing the white context; margin initially incurved, later straight, appendiculate. LAMELLAE free, initially whitish, turning yellowish white (4A2) with age, moderately crowded, up to 4 mm wide, with lamellulae in 3–5 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 25–34 × 4–5 mm, central, terete, almost equal, with a subbulbous to bulbous base, fistulose becoming hollow with age; surface whitish to orange-white (5A2) or light brown (6D4) turning brownish orange (7C3) on bruising, with discrete, fibrillose, dark brown (6E8) squamules forming broken girdles towards the lower portion; base arising from white mycelial cords. ANNULUS as a distinct zone of dark brown (6E8) persistent fibrillose squamules, occupying an inferior to central position on the stipe. CONTEXT up to 2 mm thick, whitish. ODOUR not distinctive. SPORE-PRINT white.

SPORES 4.5–6 × 3–4.5 (5.28 ± 0.82 × 3.8 ± 0.36) µm, Q = 1.2–1.7, Qm = 1.39, ovo-ellipsoid to ellipsoid, hyaline, with an oil guttule, smooth, thick-walled (up to 1 µm), dextrinoid, non-metachromatic, cyanophilic. BASIDIA 20–25 × 6–8 µm, clavate, with guttulate contents, bearing 4 sterigmata up to 4 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 12–32 × 5.5–10 µm,

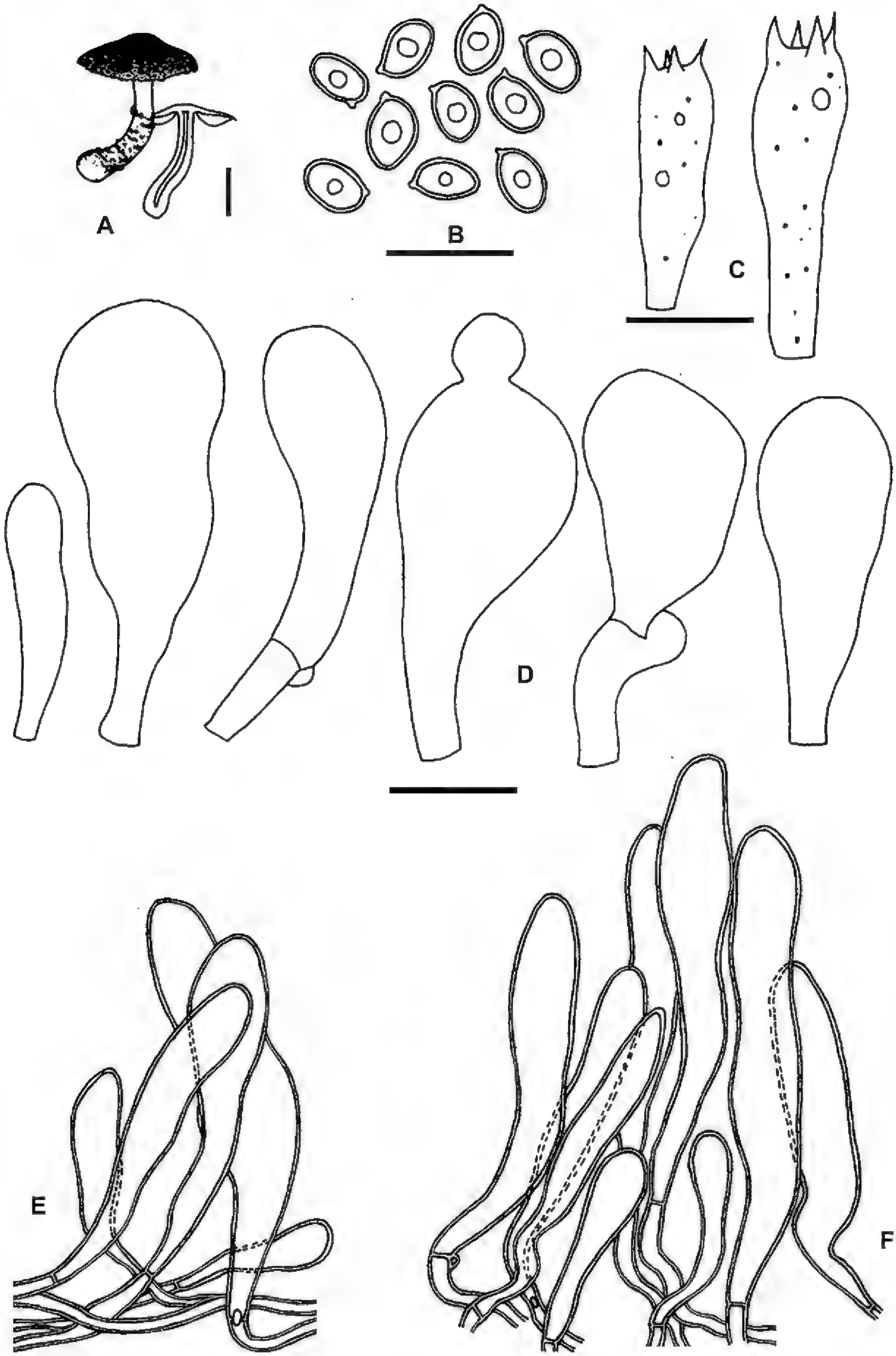

FIGURE 3. *Lepiota zalkavritha*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

narrowly clavate, clavate, broadly clavate, obpyriform, some with a subcapitate or rarely elongated apex (up to 30 µm long), at times septate, slightly inflated, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–10 µm wide, hyaline, thin-walled, septate, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–16 µm wide, inflated, hyaline to pale yellowish, thin- to slightly thick-walled, inamyloid. PILEAL COVERING a trichodermium with erect or ascending terminal elements, 36–120 × 7–23 µm, mostly subfusoid or cylindric with obtuse tips, younger elements invariably clavate, thick-walled (up to 1 µm), with brownish to dark brownish plasmatic and membrane pigments. STIPE COVERING a cutis with occasional trichodermial patches of ascending or erect, cylindric, fusoid or clavate terminal elements 40–125 × 7–23 µm, thick-walled (up to 1 µm), with brownish to dark brown plasmatic and membrane pigments. All hyphae with clamp connections.

HABITAT: On soil, solitary.

ADDITIONAL COLLECTIONS EXAMINED — INDIA, Kerala State, Calicut District, PUTHIYANGADI: 9 October 2006, Arun Kumar AK453 (K(M)157134); 11 November 2006, Arun Kumar AK442a; 27 November 2006, Arun Kumar AK442b.

DISCUSSION: This species clearly belongs in the section *Ovisporae* because of the ovoid spores and trichodermial nature of the pileal covering, but stands out from all the species described in that section owing to its unique combination of characters. The small spores, versiform cheilocystidia with occasional apical outgrowths, and the rather short (36–120 µm long), clavate, fusoid or cylindric pileal elements with brown to dark brown plasmatic and membrane pigments are diagnostic of this species. *Lepiota helveola* Bres., a species with a world-wide distribution (Guzmán & Guzmán-Dávalos 1992), seems to be a related species with almost similar cheilocystidial shapes and dimensions. Also, the elements of pileal covering in both species show a close morphological resemblance. However, *L. helveola* has larger basidiomata (Bon 1996: 57) and possess conspicuously larger spores (Huijsman 1962, Migliozzi 1997). A distant similarity with *L. azalearum* (Murrill) Dennis (Dennis 1952, 1970; Pegler 1983) could be attributed but that species clearly differs by its reddish brown pileus, evanescent annulus, spores that are less broad (2.5–3 µm), and fusiform pileal elements with pointed apex.

Lepiota brevipes Murrill, Quart. J. Florida Acad. Sci. 8(2): 178 (1945)

COLLECTIONS EXAMINED — INDIA, Kerala State, Calicut District, PUTHIYANGADI: 27 October 2003, Arun Kumar AK7 (K(M)157127); 8 May 2004, Arun Kumar AK22; 12 May 2004, Arun Kumar AK22a; 13 May 2004, Arun Kumar AK22b; 16 May 2004, Arun Kumar AK22c; 18 May 2004, Arun Kumar AK22d; 10 October 2004, Arun Kumar AK130; KOYILANDI, 27 October 2004, Arun Kumar AK156; 3 November 2004, Arun Kumar AK167; PERUVANNAMUZHI, 13 November 2004, Arun Kumar AK193.

Discussion: This species has a yellowish white to cream-coloured pileus with brown to reddish brown appressed squamules, whitish to yellowish white lamellae, stipe covered with brownish squamules in broken girdles, small oblong-ellipsoid to cylindric spores, and a trichodermial pileal covering with ascending or erect cylindric to flexuouse terminal elements. Owing to the oblong-ellipsoid to subcylindric spores and the trichodermial nature of pileal covering, this species belong in section *Ovisporae*. The present collections have characters almost identical with the description of the holotype material of *L. brevipes* given by Smith (1965). They also agree with the description of that species based on the type and additional materials of the species from Florida by Akers & Sundberg (1998). The Kerala specimens however, had smaller basidiomata. This species was previously known only from Florida.

Lepiota brevipes var. ***distincta*** T.K.A. Kumar & Manim., **var. nov.** Figure 4

MycoBank MB511884

A typo differt: basidiomata roseotincta.

Holotype: INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK354 (K(M)157114, holotype).

Etymology: *distincta* (Latin), distinct

Basidiomata small. Pileus 11–16 mm diam., subglobose when young, becoming convex to broadly convex, finally applanate, with a broad umbo; surface whitish with reddish brown (8D6), appressed to recurved fibrillose squamules in broken, concentric circles that are concentrated towards the centre, pruinose at the disc, with an overall rosy tinge; margin initially incurved, later straight, appendiculate. Lamellae free, white, crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. Stipe 25–70 × 2–3 mm, central, terete, almost equal, with a subbulbous base, fistulose; surface whitish to brownish orange (7C5), usually more whitish approaching the apex, with reddish brown (8D6), scattered fibrillose scales that are less towards the upper portion and concentrated towards the base; base arising from white mycelial cords. Annulus as a disrupted fibrillose zone, reddish brown. Context less than 1 mm thick, whitish. Odour not distinctive. Spore-print not obtained.

Spores 4–5 × 3 (4.8 ± 0.31 × 3 ± 0) µm, Q = 1.3–1.7, Qm = 1.6, ovo-ellipsoid to ellipsoid or subcylindric, hyaline, with oil guttules, smooth, thin- to slightly thick-walled, dextrinoid, non-metachromatic, cyanophilic. Basidia 14–18 × 6–7 µm, cylindrico-clavate to clavate, with guttulate contents, bearing 4 sterigmata up to 4 µm long. Lamella-edge sterile. Cheilocystidia 12–32 × 5.5–10 µm, cylindrical, clavate, broadly clavate, utriform, some with median constriction, hyaline to pale yellow, slightly thick- to thick-walled (up to 1 µm), with amorphous exudates on the surface. Pleurocystidia absent.

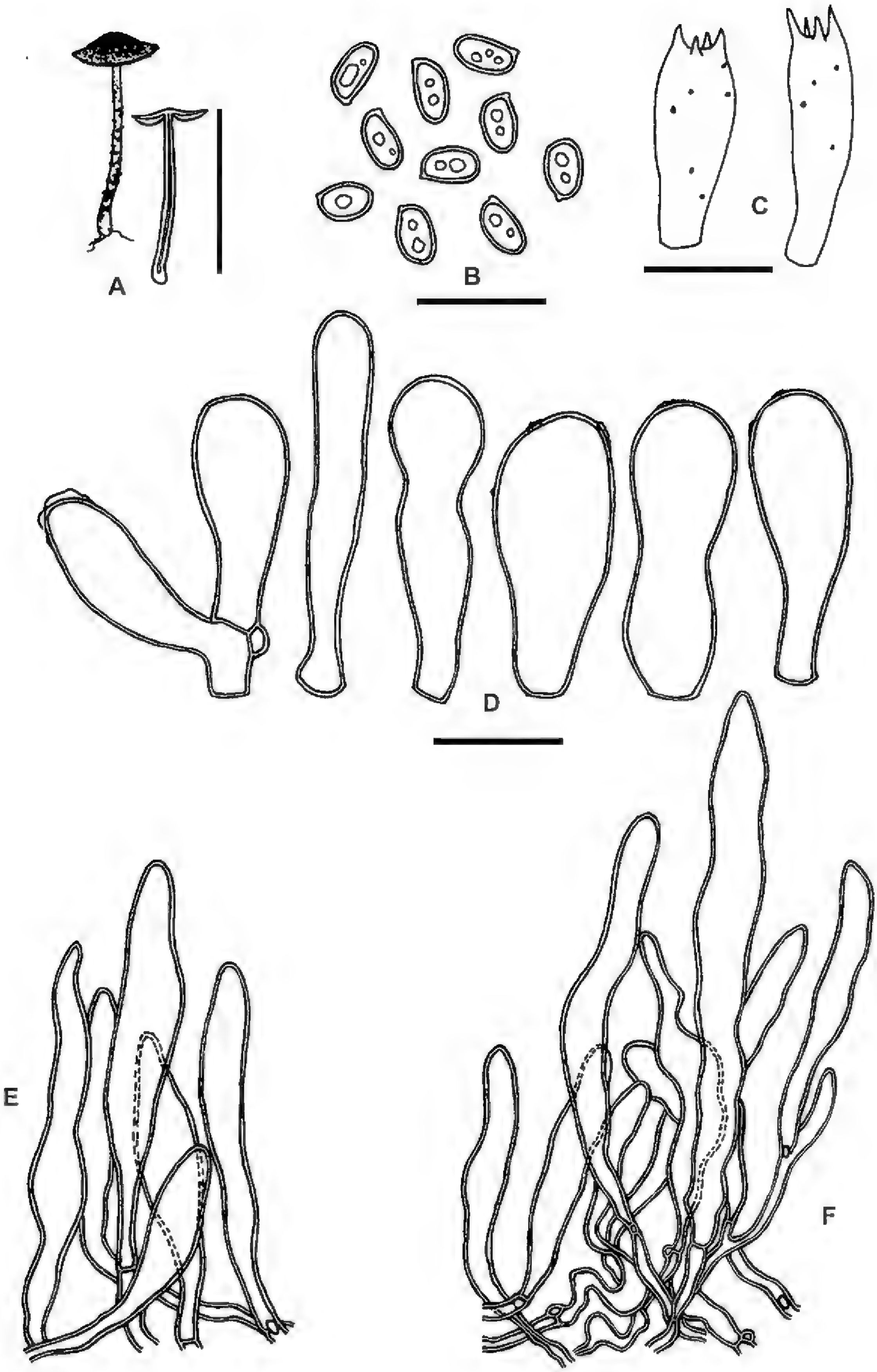

FIGURE 4. *Lepiota brevipes* var. *distincta*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

LAMELLAR TRAMA subregular; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, septate, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–20 µm wide, inflated, hyaline to pale yellowish, thin- to slightly thick-walled, inamyloid. PILEAL COVERING a trichodermium with erect or ascending terminal elements, 24–120 × 4–12 µm, mostly fusoid, rarely cylindric, clavate, flexuose, or lageniform, thick-walled (up to 1.5 µm), with brown to dark brown plasmatic and membrane pigments. STIPE COVERING a highly disrupted cutis with trichodermial patches of ascending or erect, cylindric, flexuose, fusoid, lageniform or clavate terminal elements, 30–90 × 5–10 µm, thick-walled, with brown to dark brown plasmatic and wall pigment. All hyphae with clamp connections.

HABITAT: On soil and decaying leaf litter, solitary or scattered.

OTHER COLLECTIONS EXAMINED — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 18 July 2005, Arun Kumar AK354a (K(M)157115); 20 July 2005, Arun Kumar AK372; KALLAR, 4 August 2006, Arun Kumar AK434; Calicut District, PERUVANNAMUZHI, 25 September 2006, Arun Kumar AK441.

DISCUSSION: This variety differs from the typical variety in showing a few minor variations such as an overall rose tint of the larger and more robust basidiomata, whitish pileal background, appendiculate pileal margin, white context and lamellae, and cheilocystidia with amorphous encrustations.

Lepiota xanthophylla P.D. Orton, Trans. Br. mycol. Soc. 43: 289 (1960)

COLLECTIONS EXAMINED — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 July 2005, Arun Kumar AK346 (K(M)157128); 12 July 2005, Arun Kumar AK349.

DISCUSSION: *Lepiota xanthophylla* is a yellow species with ellipsoid spores. It is known in European countries only from green houses and not from natural habitats, thereby indicating its tropical origin as mentioned by Vellinga & Huijser (1998). The present collections agree with the description of this species given by Orton (1960), Vellinga & Huijser (1998) and Vellinga (2001b). It differs from the closely related *L. elaiophylla* mainly by the presence of numerous short clavate cells along with the long cylindrical elements in the pileus covering and by the cheilocystidia which are mostly narrowly lageniform to narrowly utriform. *L. elaiophylla* lacks these distinctive elements. This is the first record of *L. xanthophylla* from India.

Lepiota elaiophylla Vellinga & Huijser, Boll. Gruppo Micol. G. Bresadola 40(2–3): 462 (1998) ["1997"]

COLLECTIONS EXAMINED — INDIA, Kerala State, Calicut District, KOYILANDY: 27 October 2004, Arun Kumar AK154 (K(M)157140); 3 November 2004, Arun Kumar AK154a (K(M)157141); 3 November 2004, Arun Kumar AK168; 20 November 2004, Arun Kumar AK154b; 13 October 2006, Arun Kumar AK456; Malappuram District,

CALICUT UNIVERSITY CAMPUS, 8 June 2005, Arun Kumar AK239; 9 June 2005, Arun Kumar AK239a; 21 June 2005, Arun Kumar AK281.

Discussion: This yellow *Lepiota* has characteristics that match with the original description of *L. elaiophylla*. Vellinga & Huijser (1998) distinguish this species from *L. xanthophylla* primarily by the lack of a layer of clavate short elements in-between the cylindric to fusiform terminal elements in the pileus. Until now *L. elaiophylla* has only been reported from green houses in Europe. This report is the first record of this species from a tropical region.

Lepiota ianthinosquamosa Pegler, Kew Bull., Addit. Ser. 9: 389 (1983)

Collections examined — INDIA, Kerala State, Calicut District, PERUVANNAMUZHY: 13 November 2004, Arun Kumar AK195 (K(M)157142); 22 July 2004, Arun Kumar AK195a.

Discussion: The macro- and micromorphologic characteristics of our present collection agree well with Pegler's (1983) description of this species from the Lesser Antilles, except for the slightly smaller spores and larger pileal elements. The lacrymoid to subcylindric spores and the trichodermial pileal covering place this species in the section *Ovisporae*. Macroscopically this species is somewhat similar to *L. fuscovinacea* F.H. Møller & J.E. Lange, but *L. ianthinosquamosa* clearly differs in having darker coloured fruit bodies, larger and distinctly lacrymoid spores, and clamp connections. *Lepiota ianthinosquamosa* has so far been reported only from the Lesser Antilles, this report is the first record of it occuring in the paleotropics.

Lepiota viriditincta (Berk. & Broome) Sacc., Syll. Fung. 5: 59 (1887)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 November 2004, Arun Kumar AK177 (K(M)157145); 9 November 2004, Arun Kumar AK180; 10 November 2004, Arun Kumar AK177a; 27 June 2005, Arun Kumar AK319.

Discussion: *Lepiota viriditincta* is a small species that exhibits a greyish green discolouration on bruising on all parts of the basidioma. It has a white pileus covered with minute brown squamules and finely striate towards the margin, an evanescent annulus, amygdaliform spores, and a pileal covering disrupted by trichodermial patches of cylindric to clavate terminal elements with brown plasmatic and encrusting pigments.

Characteristics of the present collections agree well with those of the species provided by Manimohan et al. (1988) from Kerala and by Pegler (1972, 1986) from Sri Lanka (based on the holotype at Kew) except for the somewhat smaller basidiomata and slightly larger spores. The lamella-edge was not recovered from the Sri Lankan material that Pegler studied and hence details on the cheilocystidia are lacking in his description. Manimohan et al. (1988) noted

the absence of cystidia in their collections from Kerala. The present collections from Kerala too, did not show cheilocystidia in any of the specimens.

Lepiota anupama T.K.A. Kumar & Manim., **sp. nov.** FIGURE 5

MycoBank MB511880

Pileus 15–20 mm latus, convexus vel companulatus, applanato expansus, umbonatus, albidus, squamulis griseobrunneis furfuraceis ad discum confortioribus obtectus, ad margineum striatus. Lamellae liberae, albae, confertae. Stipes 23–40 × 2–3 mm, ad basim leniter incrassatus, albidus. Sporae 5–7 × 3.5 μm, late ellipsoideae, hyalinae, dextrinoideae. Basidia 14–20 × 7–10 μm, clavata, 4- sporigera. Acies lamellarum sterilis. Cheilocystidia 20–59 × 6–15 μm, cylindrico-clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composite. Hyphae raro fibulatae.

HOLOTYPE: INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 June 2006, Arun Kumar AK400 (K(M)155993, HOLOTYPE).

ETYMOLOGY: *anupama* (Sanskrit), without comparison

BASIDIOMATA small. PILEUS 15–20 mm diam., initially convex, becoming campanulate to broadly convex, applanate on maturity, obtusely umbonate at the disc; surface whitish with brownish grey (8F2, 11E2, 11F2) to reddish grey (12F2) flaky squamules concentrated more towards the disc, finely sulcate-striate towards margin; margin incurved, becoming straight, entire, becoming fissile with age. LAMELLAE free, white, crowded, up to 2.5 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 23–40 × 2–3 mm (up to 5 mm at base), central, terete, almost equal above the annulus, expanding towards the base, solid when young, becoming hollow; surface whitish, almost glabrous to slightly fibrillose; base arising from a white mycelium. ANNULUS superior, membranous, ascending, fixed, whitish. CONTEXT less than 1 mm thick, white. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5–7 × 3.5–5 (5.7 ± 0.4 × 4 ± 0.2) μm, Q = 1.25–1.5, Qm = 1.44, oblong-ellipsoid to broadly ellipsoid, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 14–20 × 7–10 μm, clavate, rarely broadly clavate, with guttulate contents, bearing 4 sterigmata up to 3 μm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA 20–59 × 6–15 μm, cylindrico-clavate to cylindric-flexuose, rarely with a subcapitate apex, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 3–31 μm wide, inflated, septate, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–22 μm wide, hyaline, thin-walled, septate, inamyloid. PILEAL COVERING a cutis of filamentous repent hyphae disrupted by trichodermial patches of agglutinated hyphal bundles with cylindrical, clavate or ellipsoid, 12–65 × 5–12 μm large, thin- to slightly thick-

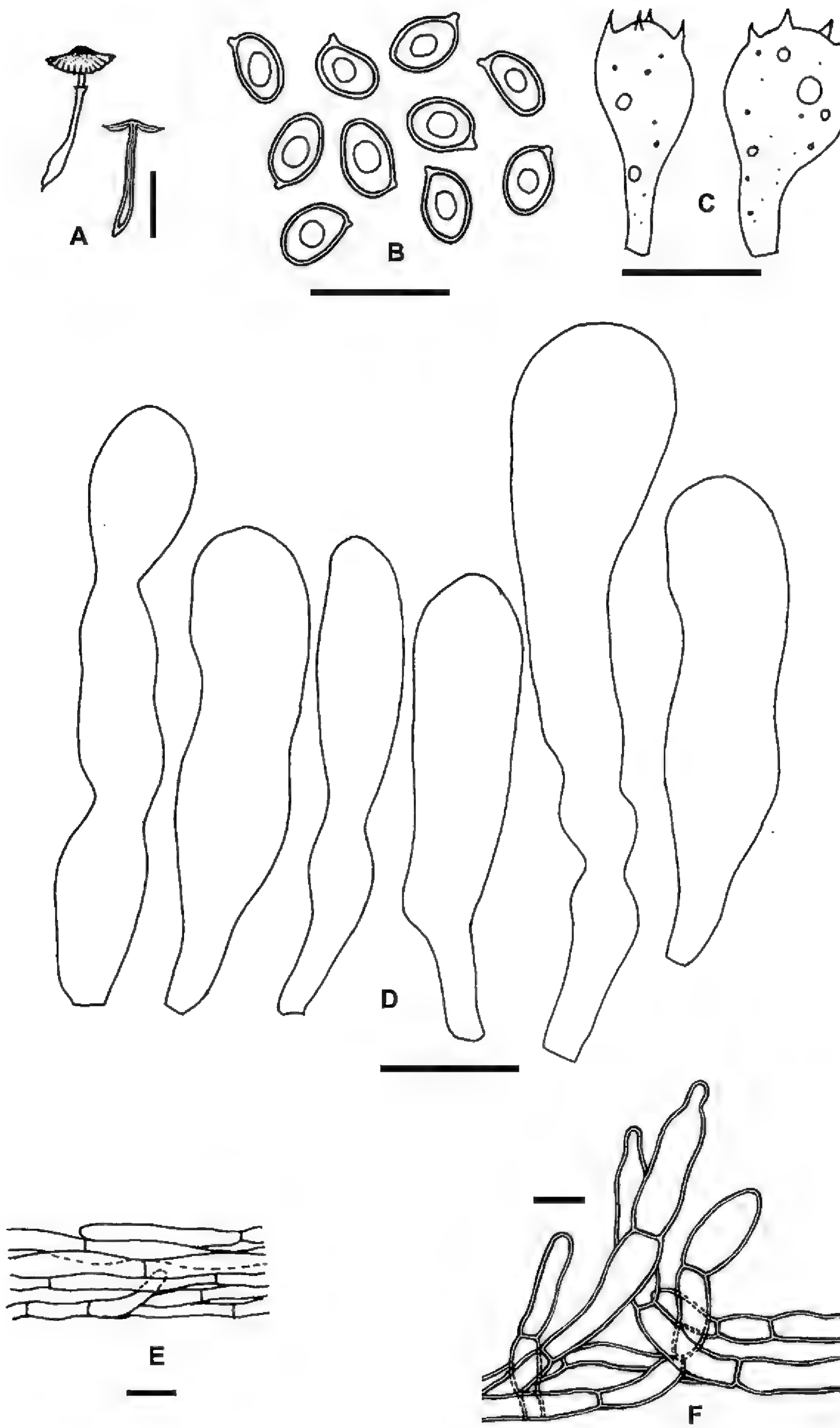

Figure 5. *Lepiota anupama*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

walled terminal elements with obtuse or acuminate tips and dense brownish grey to dark grey plasmatic pigment. Stipe covering a cutis of 3–15 µm wide, hyaline, thin-walled hyphae with cylindrical, 22–43 × 5–8 µm large terminal elements. Clamp connections rare, observed only from hyphae of the pileal covering.

Habitat: On humus rich soil, solitary or scattered.

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 24 May 2004, Arun Kumar AK33; 26 May 2004, Arun Kumar AK33a; 26 May 2004, Arun Kumar AK38; 6 June 2005, Arun Kumar AK234; 20 November 2006, Arun Kumar AK460; Calicut District, PUTHIYANGADI, 12 November 2003, Arun Kumar AK13 (K(M)157116); 14 November 2003, Arun Kumar AK13a; 17 August 2004, Arun Kumar AK91 (K(M)157117); KOLAMALA, 19 July 2006, Arun Kumar AK420.

Discussion: A white pileal surface with scattered flaky squamules and finely striate margin, a fixed membranous annulus, oblong-ellipsoid to broadly ellipsoid spores, and a pileal covering that is basically a cutis but disrupted by trichodermial patches with cylindrical, clavate or ellipsoidal terminal elements are the major distinguishing features of this species, and do not exactly match with those of any of the known taxa. It is somewhat similar to *Lepiota columbicolor* (Berk. & Broome) Sacc. as described by Pegler (1972, 1986). However, *L. columbicolor* differs from the Kerala material because of the following characteristics of the former: 1) greyish pileal and stipe surface; 2) pink lamellae with brownish edge; 3) grey context; 4) narrower spores with slight apical attenuation; 5) cheilocystidia with greyish plasmatic pigment; and 6) an entirely cutis-type pileal covering. Macro-morphologically, *L. lilacea* Bres. from Venezuela (Dennis 1961) somewhat resembles the present species but has a vinaceous-cinnamon stipe, an annulus that is dark purplish grey beneath, and squamules composed of a hymeniform layer of clavate terminal cells.

Lepiota anupama is very common in the Calicut and Malappuram Districts of Kerala and it has been observed to fruit immediately on the onset of monsoon. Fruiting continues for about one-and-a-half weeks and gradually stops with increasing rainfall.

Lepiota ananya T.K.A. Kumar & Manim., **sp. nov.** Figure 6

MycoBank MB511876

Pileus 14–25 mm latus, primo convexus, postea applanatus, umbonatus, albidus, squamulis appressis atro-brunneis ad discum confertioribus obtectus, ad marginem subtiliter striatus. Lamellae liberae, pallide luteae, confertae. Stipes 22–40 × 1.5–5 mm, ad basim incrassatus, albidus, fibrillosus. Sporae 5.5–8 × 3.5–4.5 µm, amygdaliformiae, hyalinae, dextrinoideae. Basidia 13–21 × 8–10 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 15–37 × 7.5–10 µm, versiformia, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.

HOLOTYPE — INDIA, Kerala State, Thiruvananthapuram District, PALODE: 15 July 2005, Arun Kumar AK351 (K(M)155996, HOLOTYPE).

ETYMOLOGY: *ananya* (Sanskrit), unique

BASIDIOMATA small. PILEUS 14–25 mm diam., initially convex, becoming broadly convex and finally applanate, distinctly umbonate at the disc; surface whitish, sometimes with a yellowish tinge, with dark brown (8F8) appressed fibrillose squamules more concentrated towards the centre, almost smooth at the disc, finely striate towards the margin; margin initially incurved, later straight, crenate. LAMELLAE free, pale yellow (2A2) to light yellow (3A5), crowded, up to 3 mm wide, with lamellulae in 3–4 tiers; edge fimbriate under a lens, concolorous with the sides. STIPE 22–40 × 1.5–5 mm, central, terete, expanding towards base, initially fistulose, becoming hollow; surface whitish, fibrillose; base arising from a white mycelium. ANNULUS superior, membranous, ascending, whitish. CONTEXT up to 2 mm thick, whitish to pale yellow (2A2). ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 5.5–8 × 3.5–4.5 (5.7 ± 0.9 × 4 ± 0.22) µm, Q = 1.3–2, Qm = 1.6, amygdaliform, thick-walled (up to 1 µm), hyaline, with refractive guttules, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 13–21 × 8–10 µm, clavate, some broadly clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 5 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 15–37 × 7.5–10 µm, cylindrical, clavate, or utriform, some septate, rarely constricted, thin-walled, hyaline or pale yellowish. PLEUROCYSTIDIA none. LAMELLAR TRAMA subregular; hyphae 2–17 µm wide, thin-walled, hyaline to pale yellow, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–17 µm wide, cylindrical, thin-walled, hyaline to pale yellowish, inamyloid. PILEAL COVERING a cutis of interwoven filamentous hyphae, with occasional ascending or erect terminal elements; hyphae 3–14 µm wide, thin- to slightly thick-walled and with brown to dark grey plasmatic, membrane and encrusting pigments. STIPE COVERING a cutis of repent, cylindrical, 2–10 µm wide, thin-walled, hyaline hyphae. Clamp connections rare.

HABITAT: On decaying leaf litter, solitary or scattered.

DISCUSSION: Yellowish lamellae, amygdaliform spores, a cutis-type pileal covering composed of cylindrical hyphae with brown to dark grey plasmatic, membrane- and encrusting pigments, and rare clamp connections make this species unique. *Lepiota epicharis* (Berk. & Broome) Sacc. seems to be very close to the present species except for the pileal covering, which is a disrupted epithelium of inflated clavate or pyriform elements (Pegler 1986) in that species.

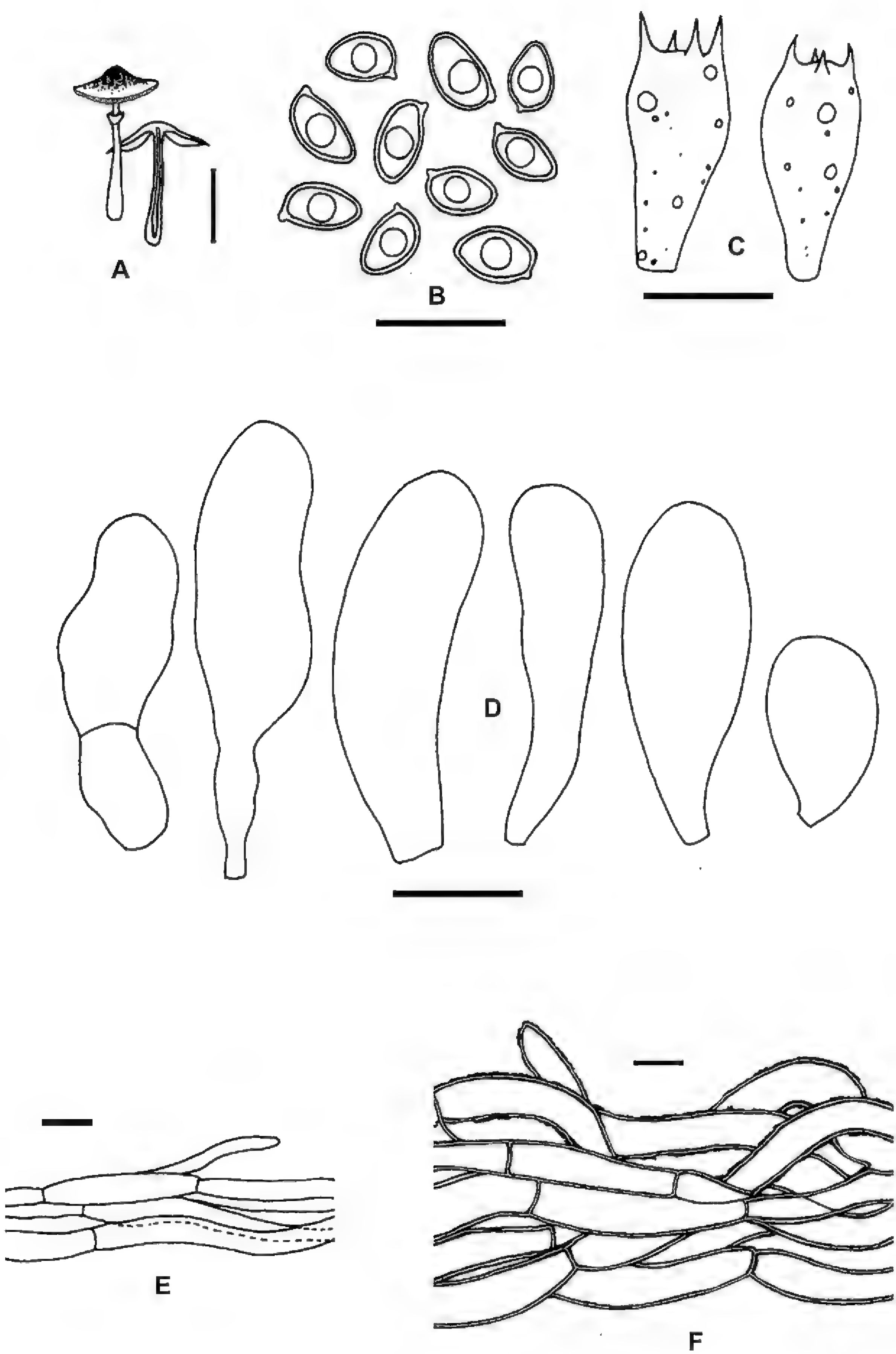

FIGURE 6. *Lepiota ananya*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

Lepiota babruzalka T.K.A. Kumar & Manim., **sp. nov.** FIGURE 7

MycoBank MB511881

Pileus 10–13 mm latus, primo subglobosus, postea convexus vel applanatus, umbonatus, albidus, squamulis minutis appressis rubro-brunneis ad discum confertioribus obtectus, ad marginem non-striatus. Lamellae primo albidae, postea pallide luteae, confertae. Stipes 26–45 × 1–1.5 mm, ad basim bulbosus, albidus, obscure fibrillosus. Sporae 5.5–10.5 × 3.5–4.5 µm, oblongo-ellipsoideae vel subcylindricae, hyalinae, dextrinoideae. Basidia 15–20 × 7–8 µm, clavata, 1- ad 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 13–32 × 7–12 µm, cylindrico-clavata vel clavata, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae perraro fibulatae.

HOLOTYPE — INDIA, Kerala State, Calicut District, CHELAVUR: 12 November 2004, Arun Kumar AK191 (K(M)155995, HOLOTYPE).

ETYMOLOGY: *babruzalka* (Sanskrit), brown-scaled

BASIDIOMATA small. PILEUS 10–13 mm diam., subglobose when young, becoming broadly convex to applanate, obtusely umbonate at the disc; surface dull white with scattered, minute, appressed, reddish brown (8E5, 8E6) squamules that are concentrated at the disc, non-striate; margin initially incurved, becoming straight, appendiculate. LAMELLAE free, white, turning orange-white (5A2) on maturity, crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 26–45 × 1–1.5 mm, central, terete, almost equal with a bulbous base, initially solid, becoming fistulose; surface dull white, becoming light brown (7D7) on bruising, faintly fibrillose. ANNULUS superior, membranous, ascending, movable, evanescent, whitish. CONTEXT less than 1 mm thick, whitish to dull white. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5.5–10.5 × 3.5–4.5 (7.5 ± 0.97 × 4 ± 0.23) µm, Q = 1.4–2.4, Qm = 1.9, oblong-ellipsoid, subcylindric, or rarely subamygdaliform, hyaline, with a refractive guttule, thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 15–20 × 7–8 µm, clavate, with guttulate contents, hyaline, 1–4-spored; sterigmata up to 8 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA abundant, 13–32 × 7–12 µm, mostly cylindrico-clavate to clavate, rarely broadly clavate, utriform or ventricose-rostrate, occassionally septate, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 3–15 µm wide, inflated, septate, thin-walled, hyaline to pale yellow, inamyloid. SUBHYMENIUM cellular, prominent, up to 10 µm wide. PILEAL TRAMA interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. PILEAL COVERING a differentiated, disrupted cutis becoming more or less trichodermial towards the disc; terminal elements 13–31 × 4–7 µm, cylindrical or clavate, thin- to slightly thick-walled, with obtuse or acuminate apices and with brownish grey to dark grey plasmatic, membrane and encrusting pigments; elements towards the margin sparsely pigmented. STIPE COVERING a

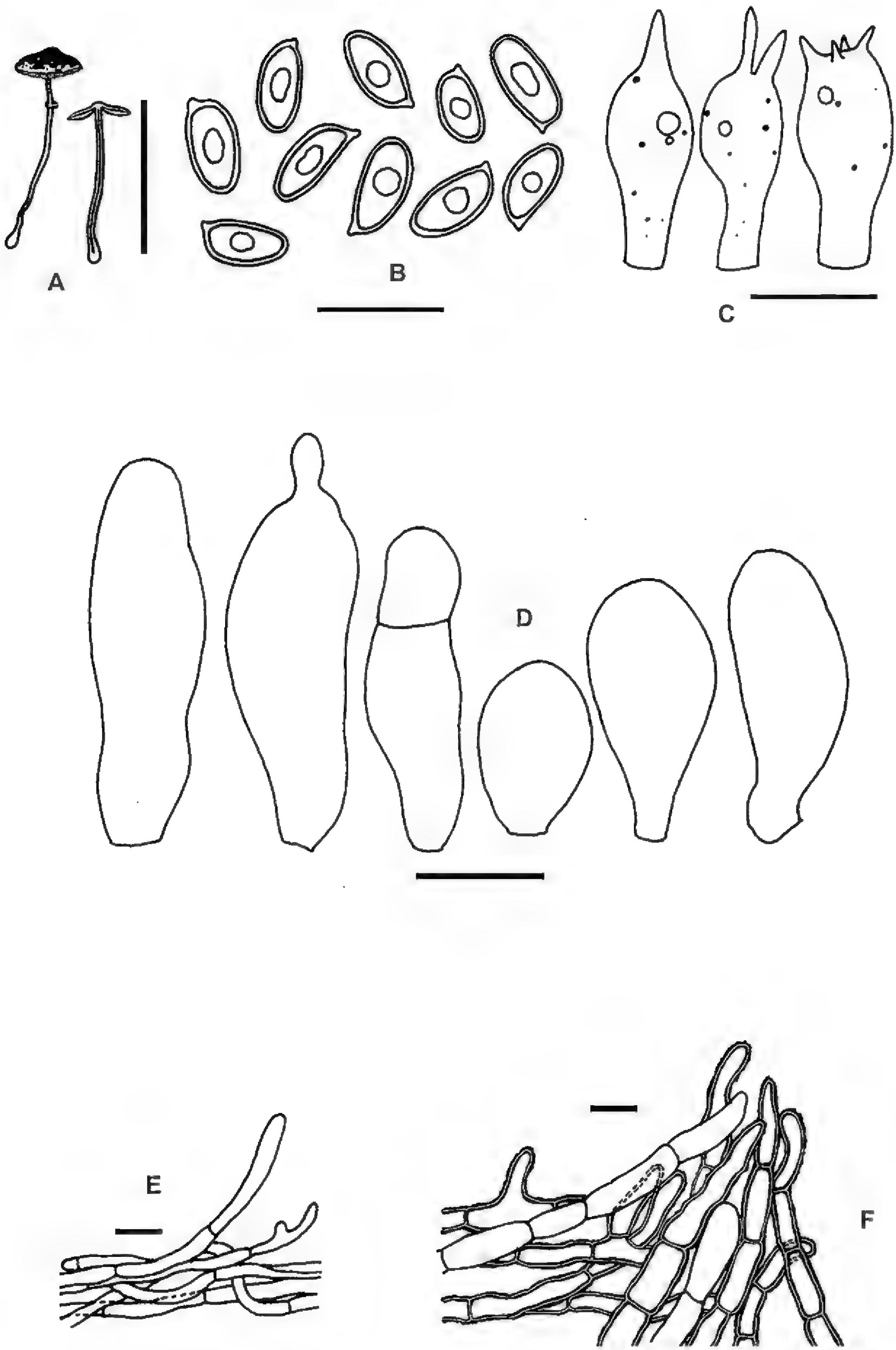

Figure 7. *Lepiota babruzalka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

disrupted cutis with occassional ascending or erect, cylindrico-clavate terminal elements, 14–40 × 6–8 µm, thin-walled, hyaline or with pale grey plasmatic pigment. Clamp connections very rare.

HABITAT: On soil among decaying leaf litter around the base of bamboo stands, solitary or scattered.

OTHER COLLECTIONS EXAMINED — INDIA, Kerala State, Calicut District, CHELAVUR: 21 November 2004, Arun Kumar AK191a (K(M)157129); 8 October 2006, Arun Kumar AK191b (K(M)157130); Malappuram District, NILAMBUR, 11 October 2006, Arun Kumar AK455.

DISCUSSION: A long, slender, but more or less firm, stipe, one- to four-spored basidia, versiform cheilocystidia, and a trichodermial pileal disc composed of cylindrical or clavate terminal elements with plasmatic, membrane, and encrusting pigments are the distinguishing features of this species.

Lepiota roseoalba Henn., seems to be the only previously described species that is somewhat similar to the Indian specimens. A comparison with *L. roseoalba* as described by Pegler (1977) reveals that *L. babruzalka* is distinguished based on its reddish brown pileal squamules, non-striate pileus margin, slender stipe and differently pigmented cylindrical terminal elements of the pileal covering.

Lepiota shveta T.K.A. Kumar & Manim., **sp. nov.** FIGURE 8

MycoBank MB511882

Pileus 5–24 mm latus, ovoideus vel conico-companulatus, applanato expansus, albus, squamulis furfuraceis ad discum confertioribus obtectus, ad marginem estriatus. Lamellae liberae, albae, confertae. Stipes 15–32 × 1.5–4 mm, albidus, squamulis adpressis obtectus. Sporae 6–9.5 × 3.5–5 µm, oblongae vel subcylindricae, hyalinae, dextrinoideae. Basidia 17–24 × 6.5–8.5 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 14–32 × 7–13 µm, clavata vel cylindrico-clavata, hyalina, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes fibulatae.

HOLOTYPE — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 9 November 2004, Arun Kumar AK176 (K(M)155994, HOLOTYPE).

ETYMOLOGY: *shveta* (Sanskrit), white

BASIDIOMATA small. PILEUS 5–24 mm diam., ovoid when very young, becoming conico-convex and finally applanate, indistinctly umbonate; surface white, furfuraceous, appressed-fibrillose or almost pruinose in some specimens especially towards the centre; non-striate; margin initially incurved, becoming straight on maturity, appendiculate, splitting up to the middle with age. LAMELLAE free, white, close to crowded, up to 3 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 15–32 × 1.5–4 mm, central, terete, equal or rarely slightly expanded towards the base, fistulose to hollow; surface white, turning pale brownish orange (6C7) on

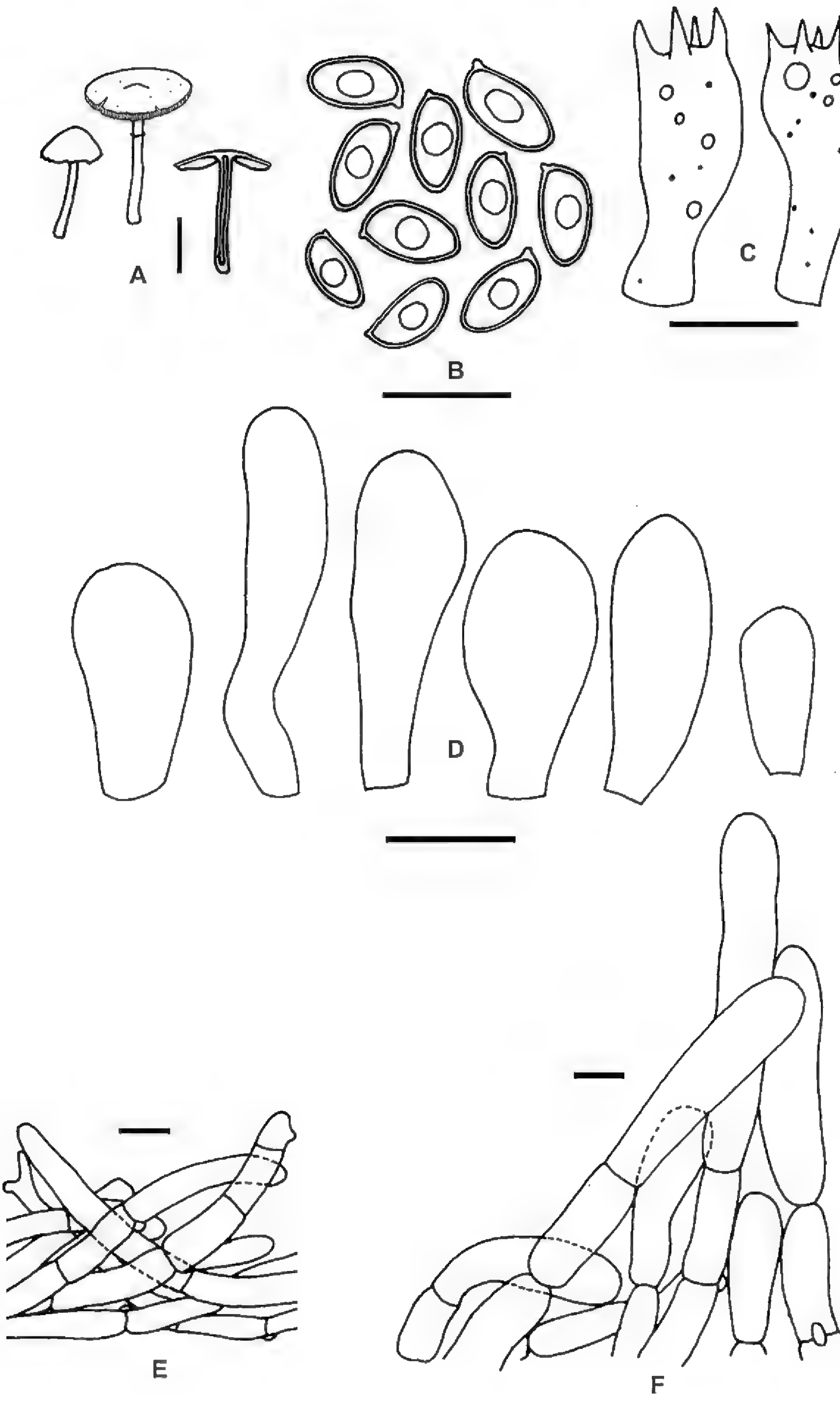

FIGURE 8. *Lepiota shveta*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

bruising, fibrillose, with minute appressed squamules; base arising from white mycelial cords. Annulus superior, fibrillose, evanescent, white. Context up to 1 mm thick, white. Odour not distinctive. Spore-print white.

Spores 6–9.5 × 3.5–5 (8 ± 0.83 × 4.25 ± 0.47) µm, Q = 1.7–2.25, Qm = 1.9, oblong to subcylindrical, rarely amygdaliform, hyaline, with guttulate contents, slightly thick-walled, smooth, dextrinoid, non-metachromatic, cyanophilic. Basidia 17–24 × 6.5–8.5 µm, clavate, often with guttulate contents, bearing 4 sterigmata up to 4.5 µm long. Lamella-edge sterile with crowded cheilocystidia. Cheilocystidia 14–32 × 7–13 µm, clavate to cylindrico-clavate, hyaline, thin-walled. Pleurocystidia none. Lamellar trama subregular; hyphae inflated, septate, 2–25 µm wide, hyaline, thin-walled, inamyloid. Subhymenium up to 20 µm wide, cellular. Pileal trama somewhat interwoven; hyphae of 2–28 µm wide, highly inflated, septate, hyaline, thin-walled, inamyloid, branched. Pileal covering a disrupted cutis of 3–14 µm wide, thin-walled, hyaline to pale brown or pale grey filamentous hyphae with trichodermial patches of erect or ascending hyphal bundles with clavate, cylindrical or cylindrico-clavate end cells, 15–65 × 4–15 µm, with obtusely rounded apices and pale grey plasmatic pigments. Stipe covering a highly disrupted cutis with ascending agglutinated or loose hyphal elements with cylindrical, unpigmented end cells, at times branched towards the apex. Clamp connections rare.

Habitat: On soil and decaying leaf litter, solitary or scattered.

Other collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 4 October 2004, Arun Kumar AK117 (K(M)157118); 5 October 2004, Arun Kumar AK117a (K(M)157119); 9 November 2004, Arun Kumar AK117b; 10 November 2004, Arun Kumar AK183; 16 November 2004, Arun Kumar AK201.

Discussion: This species is characterized by: 1) white basidiomata; 2) change of colour of stipe to pale brownish orange on bruising; 3) large, mostly oblong to subcylindrical spores; 4.) cylindrico-clavate to clavate cheilocystidia 5) cylindrical to clavate pileal elements; and 6) clamp connections. This combination of characters makes it distinct from all other previously described taxa. *Lepiota amplifolia* Murrill is a species that comes close because of the macromorphological affinities, but it has 'isabelline-testaceous' scales on the pileus, 'triangular' lamellae, 7–9 cm long stipe that becomes rose-tinted on drying, and large spores that are 8–9 × 3.5 µm (Murrill 1912). *Leucoagaricus serenus* (Fr.) Bon & Boiffard is a species that show a high degree of macroscopic similarity but microscopically it is very different (Vellinga 2001c). This species is very common in the Malappuram District of Kerala, especially in the Calicut University Campus and adjoining areas.

Lepiota harithaka T.K.A. Kumar & Manim., **sp. nov.** FIGURE 9

MycoBank MB511883

Basidiomata contusae griseo-virido decolorans. Pileus 20–35 mm latus, convexus, applanato expansus, postremo depressus, albidus, squamulis granularis brunneis ad discum confertioribus obtectus, non-striatus. Lamellae liberae, pallide luteae, confertae. Stipes 43–72 × 2–4 mm, equalis vel basim leniter incrassatus, albidus. Sporae 5–7 × 3–4 µm, ellipsoideae vel amygdaliformiae, hyalinae, crassitunicatae, dextrinoideae. Basidia 14–20 × 5–7 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 20–39 × 7–21 µm, clavata, raro utriformia, cristata. Pleurocystidia nulla. Trama hymenophoralis subregularis. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Fibula non visa.

HOLOTYPE — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 6 June 2006, Arun Kumar AK388 (K(M)155997, HOLOTYPE).

ETYMOLOGY: *harithaka* (Sanskrit), greenish

BASIDIOMATA small, all parts turning greyish green (27E5) on bruising. PILEUS 20–35 mm diam., convex when young, becoming broadly convex, then applanate and finally depressed with maturity, with an indistinct umbo; surface dull white, with scattered brown (6E5-7E5) fibrillose squamules giving a granular appearance, non-striate; squamules concentrated towards the centre, appearing almost pruinose at the disc, sparse towards the margin, margin initially incurved, later straight, entire. LAMELLAE free, crowded, up to 5 mm wide, pale yellow (1A3, 2A3), with lamellulae in 8–9 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 43–72 × 2–4 mm (up to 6 mm at the base), central, terete, almost equal or expanded towards the base, slightly bulbous at the base, fistulose; surface whitish to dull white, smooth, fibrillose; base arising from a white mycelium. ANNULUS superior, membranous, evanescent, whitish. CONTEXT up to 5 mm thick at the disc, whitish. ODOUR not distinctive. SPORE-PRINT yellowish white (1A2).

SPORES 5–7 × 3–4 (6 ± 0.54 × 3.8 ± 0.44) µm, Q = 1.4–2, Qm = 1.6, ellipsoid to amygdaliform, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, non-metachromatic, cyanophilic. BASIDIA 14–20 × 5–7 µm, cylindrico-clavate, clavate, hyaline to pale green, bearing 4 sterigmata up to 5 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 20–39 × 7–21 µm, mostly clavate, rarely utriform, thin- to slightly thick-walled (up to 0.5 µm), speckled with crystalline encrustations, with hyaline to greenish contents. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 3–17 µm wide, hyaline to pale green, thin- to slightly thick-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 4–20 µm wide, hyaline to pale grey, thin- to slightly thick-walled, inamyloid. PILEAL COVERING a highly disrupted cutis towards the margin, of septate, 4–15 µm wide, thin- to slightly thick-walled hyphae with pale grey to grey plasmatic and membrane pigments,

bluish green to blue pigmented at bruised parts; entirely trichodermial at the disc; terminal elements 27–65 × 10–20 µm, ellipsoid, cylindric or clavate, with obtuse apex, thin to slightly thick-walled, with pale grey to dark grey plasmatic, membrane and encrusting pigments. Stipe covering a cutis rarely disrupted by ascending hyphal elements; hyphae 4–16 µm wide, thin- to slightly thick-walled, hyaline to pale grey. Clamp connections absent.

Habitat: On soil among dead and living bamboo roots, solitary, scattered.

Other collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 15 June 2006, Arun Kumar AK396 (K(M)157132), 3 July 2006, Arun Kumar AK407 (K(M)157133); 26 September 2006, Arun Kumar AK443; 27 September 2006, Arun Kumar AK448.

Discussion: *Lepiota harithaka* is an interesting species with basidiomata that turn greyish green on bruising. It is additionally characterized by pale yellow lamellae, ellipsoid to amygdaliform spores that are non-metachromatic in cresyl blue, cheilocystidia that are clavate and slightly thick-walled with greenish plasmatic contents and crystalline surface encrustations, elements of the pileal covering with plasmatic, membrane- and encrusting pigments, and absence of clamp connections. This combination of characteristics does not match any species description so far published.

This species is kept here under the genus *Lepiota*, as the spores clearly failed to give a metachromatic reaction with cresyl blue, although the lack of clamp connections would suggest *Leucoagaricus*. Observations during this study show that presence or absence of clamp connections is not a reliable character to draw generic demarcations, as many collections from Kerala otherwise accepted under *Leucoagaricus* had clamp connections and *Lepiota* species that lack clamps are also found accepted (e.g. the section *Anomalae* Locq.; the section *Fuscovinaceae* Bon & Candusso) in the literature. Following Singer's (1986) infrageneric classification, the present species may be placed inside the section *Anomalae*, a section established as a repository for all the anomalous species lacking clamp connections. Vellinga (2003) found this section to be a very artificial group with species belonging to the other sections of *Lepiota* and *Leucoagaricus* as well. If the absence of clamp connections is taken as an exception, owing to the ellipsoid to amygdaliform spore shape and the trichodermial nature of the pileal covering, this species could be placed in the section *Ovisporae*.

There are a few *Lepiota* species with a whitish context, that show a greenish colour change on handling or when bruised. *Lepiota viriditincta*, discussed earlier, is one such species belonging to the section *Ovisporae* that has been reported from Sri Lanka (Pegler 1972, 1986) and Kerala, India (Manimohan et al. 1988). But that species has smaller basidiomata, less dense pileal squamules, larger spores, smaller cheilocystidia, and possesses clamp connections.

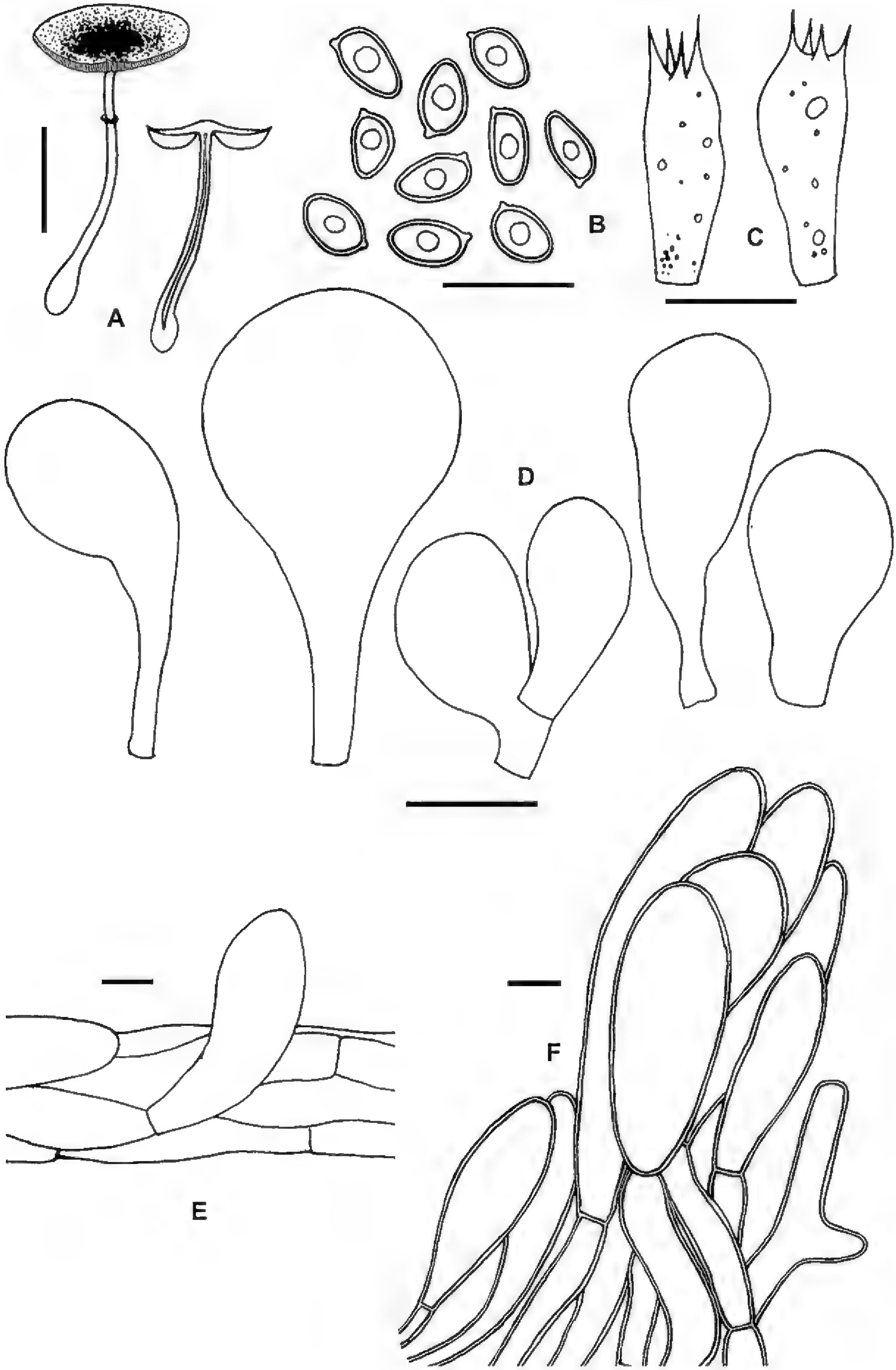

FIGURE 9. *Lepiota harithaka*: A, habit, scale bar = 10 mm;
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

Lepiota cyanescens Beeli differs in being larger-sized and with much larger spores. *Lepiota caerulescens* Peck, another white fleshed species, is known to show a combination of blue, green and reddish tints upon handling (Akers et al. 2000). The other species that turn green or bluish green on bruising, like *Lepiota viridiflava* Petch, *Leucoagaricus viridiflavoides* B.P. Akers & Angels and *Leucocoprinus sulphurellus* Pegler, have a noticeably yellow context apart from other differences (Akers et al. 2000).

Lepiota plumbicolor (Berk. & Broome) Sacc., Syll. Fung. 5: 63 (1887)

Collections examined — INDIA, Kerala State, Wayanad District, KOTTATHARA: 1 October 2004, Arun Kumar AK109 (K(M)157139); Calicut District, MANANCHIRA, 2 October 2004, Arun Kumar AK114; 5 October 2004, Arun Kumar AK114a.

Discussion: This species is characterized by: 1) a pileus covered with brownish grey or blackish, appressed squamules; 2) ellipsoid to oblong-ellipsoid spores more than 5 µm long and less than 5 µm broad; 3) pileal and stipe covering with trichodermial patches comprised of cylindrical terminal elements with brownish grey plasmatic pigment; and 4) the total absence of clamp connections. This species was placed by Pegler (1972, 1986) under the section *Anomalae* mainly because of the absence of clamp connections. The collections from Kerala have characteristics agreeing with the account of the species given by Pegler (1972, 1986), based on the type material (Thwaites 864 cum icon, December 1868, deposited at K) originally described by Berkeley & Broome from Sri Lanka. The Kerala collections, however, have whitish lamellae, fugacious annulus, and much wider cheilocystidia. This forms the first record of this species from India.

Lepiota murinocapitata Dennis, Kew Bull. 15: 114 (1961)

Collections examined — INDIA, Kerala State, Malappuram District, CALICUT UNIVERSITY CAMPUS: 26 October 2004, Arun Kumar AK152 (K(M)157143).

Discussion: This species is distinguished by its dark grey pileus with appressed squamules, white lamellae turning pale yellow, subamygdaliform spores that are non-metachromatic in cresyl blue, fixed annulus, and cuticular pileal covering with loosely arranged hyphae terminated by darkly pigmented cylindrical elements. Clamp connections are absent in this species. Most of the features of the Kerala collections point towards *Lepiota murinocapitata* originally described from Venezuela by Dennis (1961, 1970). However, in the Kerala collection the lamellae were observed to be initially white that gradually became pale yellow, the stipe showed a dull white to grey colour that turned brown on bruising, and the fibrillose annulus was persistent and without a grey-coloured edge. Despite these differences, we tentatively label the Kerala material, represented by only a single collection, as *Lepiota murinocapitata*.

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Addition to the knowledge of *Xylaria* (*Xylariaceae, Ascomycota*) in Santa Catarina, Southern Brazil

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Abstract—*Xylaria* specimens have been collected in the State of Santa Catarina, Southern Brazil, since the 19th century, primarily by European naturalists such as Ernst Ule and Alfred Möller. Few comprehensive surveys or *Xylaria* collections have been made by Brazilians in the State until recently. New knowledge has been gained from the authors' recent survey and examination of specimens from the Florianópolis metropolitan area. Among the species discussed are a new species, *Xylaria nigromedullosa*, and eleven other species, including *X. adscendens, X. allantoidea, X. anisopleura, X. comosa, X. cubensis, X. curta, X. ianthinovelutina, X. magnoliae* var. *microspora, X. mellissii, X. obovata,* and *X. telfairii*. Most collections were obtained from dead wood, with a few found growing on fallen fruits. Seven species are new records from Santa Catarina and *X. magnoliae* is a new record for Brazil. Full descriptions, illustrations, and a key to the *Xylaria* collections now curated in FLOR are provided.

Key words — pyrenomycetes, fungal taxonomy, neotropical mycobiota

Introduction

Xylaria Hill ex Schrank is a large and cosmopolitan genus of *Xylariaceae*. It is characterized by typically having more or less carbonaceous and erect stromata, usually with a stipe and a pallid entostroma. Specimens of *Xylaria* can be found abundantly in various environments, usually growing on rotten wood (Lloyd 1918a). The taxonomy of *Xylaria* species is difficult due to the polymorphism of many species and the approximately 550 available species names (Hladki & Romero 2005). As specimens of *Xylaria* are abundant in the tropics and easily

preserved, they were widely collected in Brazil by European naturalists in the 19th and 20th centuries (Dennis 1956).

Ernst Ule made the first collections of *Xylaria* in the State of Santa Catarina on the Island of São Francisco do Sul (northeast SC). Those specimens were later analyzed and published by Pazschke (1892) and Winter (1897). *Xylaria vermiculus* Sacc., collected by Ule in the Island of Santa Catarina, was reported by Sydow & Sydow (1901). However, *X. vermiculus* was later transferred to *Batistia* by Ciferri (1958) and excluded from the *Xylariaceae*. Rehm (1901) revised a further number of Ule's *Xylaria* collections.

Alfredo Möller, who started his mycological studies in 1890, had some of his *Xylaria* collections reported by Bresadola (1896) and Hennings (1902). Stadler et al. (2008) recently transferred a xylarioid species from Santa Catarina described by Möller (1901) as *Entonaema mesentericum* to *Xylaria mesenterica* (Möller) M. Stadler et al.

Rick and Theissen collected and published many articles concerning *Xylaria* species from the State of Rio Grande do Sul (Southern Brazil) at the beginning of the 20th century (Poroca 1986, Hamme & Guerrero 1997). Despite its proximity to Rio Grande do Sul, Rick gathered only two collections from Santa Catarina.

The first Brazilian contribution on *Xylaria* from Santa Catarina was by Viégas (1944), who identified three species. Twenty years later, Batista & Maia (1964) reported two *Xylaria* species collected by Reitz and Klein.

Lloyd described and illustrated several *Xylaria* species from Brazil. Torrend, Rick and Theissen were important collaborators who sent Lloyd numerous Brazilian fungal exsiccates. Regrettably, Lloyd does not specify in his works (1917; 1918a,b,c; 1920a,b; 1922; 1923; 1924a,b,c) from which Brazilian states the specimens were gathered.

Dennis (1956), in his Tropical America's *Xylaria* study, cited six species from Santa Catarina.

Xylaria species previously reported from the State of Santa Catarina are summarized in Table 1. Our current research represents the first survey dedicated to the genus in the State and our collections represent the first *Xylaria* material to be deposited in FLOR.

Materials and methods

The State of Santa Catarina is located in Southern Brazil and covers an area of 95.346 km^2. The capital city, Florianópolis (27°35' S and 48°32' W), is located on the Island of Santa Catarina, in the central eastern portion of the State. For logistic reasons, we collected *Xylaria* primarily in the Florianópolis metropolitan area near the Federal University of Santa Catarina.

TABLE 1. Species of *Xylaria* previously reported from the State of Santa Catarina, Southern Brazil.

SPECIES	LOCALITY	COLLECTOR	REFERENCE
Xylaria aphrodisiaca Welw. & Curr.	São Francisco do Sul	Ernst Ule	Pazschke (1892) Winter (1897)
X. cornu-damae (Schwein.) Fr.	Jacinto Machado	Reitz & Klein	Batista & Maia (1964)
X. cylindrica Lév.	Blumenau	Ernst Ule	Rehm (1901)
X. feejeensis (as *X. obtusissima*)	Serra Geral Blumenau	Ernst Ule Ernst Ule	Rehm (1901) Dennis (1956)
X. grammica (Mont.) Fr.	Tubarão Blumenau	Ernst Ule Alfred Möller	Rehm (1901) Hennings (1902)
X. guaranitica (Speg.) Dennis (as *X. discoidea*)	not known	Johann Rick	Dennis (1956)
X. hypoxylon	São Francisco do Sul	Ernst Ule	Pazschke (1892) Winter (1897)
X. ianthinovelutina	Blumenau Blumenau	Nina Raeder Reitz & Klein	Viégas (1944) Batista & Maia (1964)
X. ianthinovelutina (as *X. dichotoma*)	São Francisco do Sul	Ernst Ule	Pazschke (1892) Winter (1897)
X. luxurians (Rehm) Lloyd	Blumenau	Ernst Ule	Dennis (1956)
X. mesenterica (as *Entonaema mesentericum*)	Blumenau	Alfred Möller	Möller (1901) Stadler et al. (2008)
X. multiplex	Blumenau	Nina Raeder	Viégas (1944)
X. nodulosa Lloyd	not informed	Johann Rick	Dennis (1956)
X. obovata	Blumenau	Nina Raeder	Viégas (1944)
X. palmicola G. Winter	São Francisco do Sul	Ernst Ule	Pazschke (1892) Winter (1897)
X. polymorpha (Pers.) Grev. (as *X.* cfr. *schweinitzii*)	Blumenau	Alfred Möller	Hennings (1902)
X. portoricensis Klotzsch	Blumenau	Alfred Möller	Bresadola (1896)
X. scruposa (Fr.) Fr.	Brusque	Renaro Jaccoud	Dennis (1956)
X. telfairii (as *X. wrightii*)	Blumenau	Alfred Möller	Hennings (1902)
X. tricolor Fr.	São Francisco do Sul	Ernst Ule	Pazschke (1892) Winter (1897)

Collected material was air-dried and analyzed macro- and microscopically. Macroscopic descriptions are based on the teleomorphic stromata. Microscopic characters were examined and measured using light microscopy. The number of ascospores and asci measured are 20 and 10, respectively. The size of ascospores is given as length versus width, with extremes in brackets. Drawings were made with a camera lucida. Analyzed materials are deposited in Herbarium FLOR (Holmgren & Holmgren 1998).

Results

Eleven previously described taxa were identified: *Xylaria adscendens*, *X. allantoidea*, *X. anisopleura*, *X. comosa*, *X. cubensis*, *X. curta*, *X. ianthinovelutina*, *X. magnoliae* var. *microspora*, *X. mellissii*, *X. obovata* and *X. telfairii*. *Xylaria nigromedullosa* is described as a new species. Most collections were obtained from dead wood with a few from fallen fruits.

Key to *Xylaria* species identified during the Florianópolis survey

1a. On woody fruits 2
1b. On wood 3

2a. Ascospores brown, 9–13 × 4–5.5 µm, germ slit conspicuous, on leguminous fruits . . . . *X. ianthinovelutina*
2b. Ascospores yellowish to light-brown, 8–11 × 2–3 µm, germ slit inconspicuous, on *Talauma* (*Magnoliaceae*) fruits . . . . *X. magnoliae* var. *microspora*

3a. Germ slit inconspicuous or seemingly absent 4
3b. Germ slit conspicuous 5

4a. Stromatal surface smooth, stromata sessile to short-stipitate, internally white, ascospores ellipsoid-inequilateral . . . . *X. cubensis*
4b. Stromatal surface rugose by perithecial contours, stromata long-stipitate, internally black, ascospores broadly ellipsoid-inequilateral . . . . *X. nigromedullosa*

5a. Stromatal surface copper, cinnamon to light brown 6
5b. Stromatal surface dark brown to black 7

6a. Stromata up to 3 cm long, ascospores 12–14.5 × 4–5 µm, germ slit straight . . . . *X. allantoidea*
6b. Stromata up to 9 cm long, ascospores 19–26(–29) × 7–8 µm, germ slit oblique . . . . *X. telfairii*

7a. Stromatal apices usually bearing short, slender, pointed processes, stipe velvety, stromatal surface with whitish scales . . . . *X. comosa*
7b. Combination of features differing from above 8

8a. Stromatal apices sterile, flattened or mucronate 9
8b. Stromatal apices fertile, rounded 10

9a. Stromata up to 53 mm long, apices flattened, ascospores (9–)11–14.5(–5) × 3–5 µm . . . . *X. adscendens*
9b. Stromata up to 11 mm long, apices mucronate, ascospores 14–17(–19) × 6–7 µm . . . . *X. mellissii*

10a. Stromatal surface with brown scales, germ slit straight, ascospores 8–11 × 3.5–5 µm . . . . *X. curta*
10b. Stromatal surface without scales, germ slit oblique or spiraling, ascospores longer than 22 µm 11

11a. Fertile part moriform, ascospores 22–28 × 7–10 µm . . . . *X. anisopleura*
11b. Fertile part subglobose, ascospores (25–)27–35 × 7–9 µm . . . . *X. obovata*

Xylaria adscendens (Fr.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 128 (1851). FIG. 1

Stromata with fertile part cylindrical with apices sterile and flattened, single, rarely branched, often gregarious, 0.8–53 mm total length × 2–7 mm diam, stipe 7–13 mm total length × 1–2 mm diam. External surface dark brown to black, smooth to slightly roughened, punctuated by the ostioles. Internally white, cream to very light brown, becoming hollow. Perithecia completely immersed, ostioles papillate, black. Asci eight-spored, cylindrical, stipitate, 155–203 µm total length, the spore-bearing part 68–90 µm, apical ring turning dark blue in Melzer's iodine reagent, cylindrical to inverted hat-shaped, 2–3.2 × 1.5–2.2 µm. Ascospores ellipsoid-inequilateral, dark brown, unicellular, smooth, (9–)11–14.5(–15) × 3–5 µm, germ slit conspicuous, straight, running full-length of ascospore.

SUBSTRATE — undetermined decaying hardwood.

MATERIAL EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Baltazar. 03.XII.2005 (FLOR 31921); **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Mozerle. 01.IX.2006 (FLOR 31932).

TAXONOMIC REMARKS — Asci are smaller than those reported by San Martín & Roger (1989), however the ascospores are typical for the species. The examined stromata do not present ramifications as those described by Dennis (1957) but are macroscopically similar to material from Southern Brazil (Hamme 1993) and French Guiana (Callan & Rogers 1990). Dennis (1957) considered *X. adscendens* as a tropical variant of *X. hypoxylon* (L.) Grev. However, Callan & Rogers (1990) defended that these two species could be separated by cultural aspects, since *X. adscendens* produces yellow pigment in culture and slightly larger conidia.

Xylaria allantoidea (Berk.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 127 (1851).

Stromata with fertile part clavate, allantoid-cylindric to globose with rounded fertile apices, unbranched, 1.4–3 cm total length × 1.4–1.9 cm diam, short-stipitate or sessile. External surface copper, cinnamon to light-brown, smooth except for papillate ostioles, becoming cracked in reticulate pattern. Internally cream to light-brown, becoming hollow. Perithecia completely immersed, more or less globose, up to 1.0 mm diam. Asci eight-spored, cylindrical, stipitate, 135–170 µm total length × 4–5 um broad, the spore-bearing part 60–80 µm, apical ring bluing in Melzer's iodine reagent, quadrate, 2 × 2 µm. Ascospores ellipsoid-inequilateral, brown, unicellular, smooth, 12–14.5 × 4–5 µm, germ slit conspicuous, straight, less than ascospore-length.

SUBSTRATE — undetermined decaying hardwood.

Material examined — **BRAZIL. Santa Catarina: Florianópolis**. Ribeirão dos Três Córregos. col. Laudares. 28.XI.1983 (FLOR 10023); **BRAZIL. Santa Catarina: Florianópolis**. São João do Rio Vermelho. col. Furlani & Loguercio-Leite. 21.III.1986 (FLOR 10308); **BRAZIL. Santa Catarina: Florianópolis**. São João do Rio Vermelho. col. Loguercio-Leite 105. 15.V.1986 (FLOR 10395); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz**. Hotel Caldas da Imperatriz. col. Trierveiler-Pereira. 26.V.2007 (FLOR 31938).

Taxonomic remarks — The examined material is typical for the species. Both *X. allantoidea* and *X. telfairii* have cinnamon stromatic surfaces, making them distinct from all others described herein. However, *X. telfairii* has larger stromata, bigger ascospores and an oblique germ slit. X. *allantoidea* also resembles *X. cubensis* (see discussion of *X. cubensis* herein).

Xylaria anisopleura (Mont.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 127 (1851). Fig. 2

Stromata with fertile part globose, subglobose to clavate, with rounded fertile apex, unbranched, solitary to cespitose, 0.6–1.1 cm total length × 0.2–0.9 cm diam, sessile or short-stipitate, stipe black, 0.1–0.5 cm high × 0.1–0.2 cm wide. External surface very dark-brown to black, moriform. Internally white, not becoming hollow. Perithecia immersed, up to 1 mm diam. Asci eight-spored, cylindrical, stipitate, 240–289 µm total length × 7–10 µm broad, the spore-bearing part 146–166 µm, apical ring turning very dark blue in Melzer's iodine reagent, urn-shaped, 5.2–7 µm high × 3.5–5 µm broad. Ascospores ellipsoid-inequilateral, very dark brown, unicellular, smooth, 22–28 × 7–10 µm, germ slit conspicuous, spiraling or oblique, less than ascospore-length.

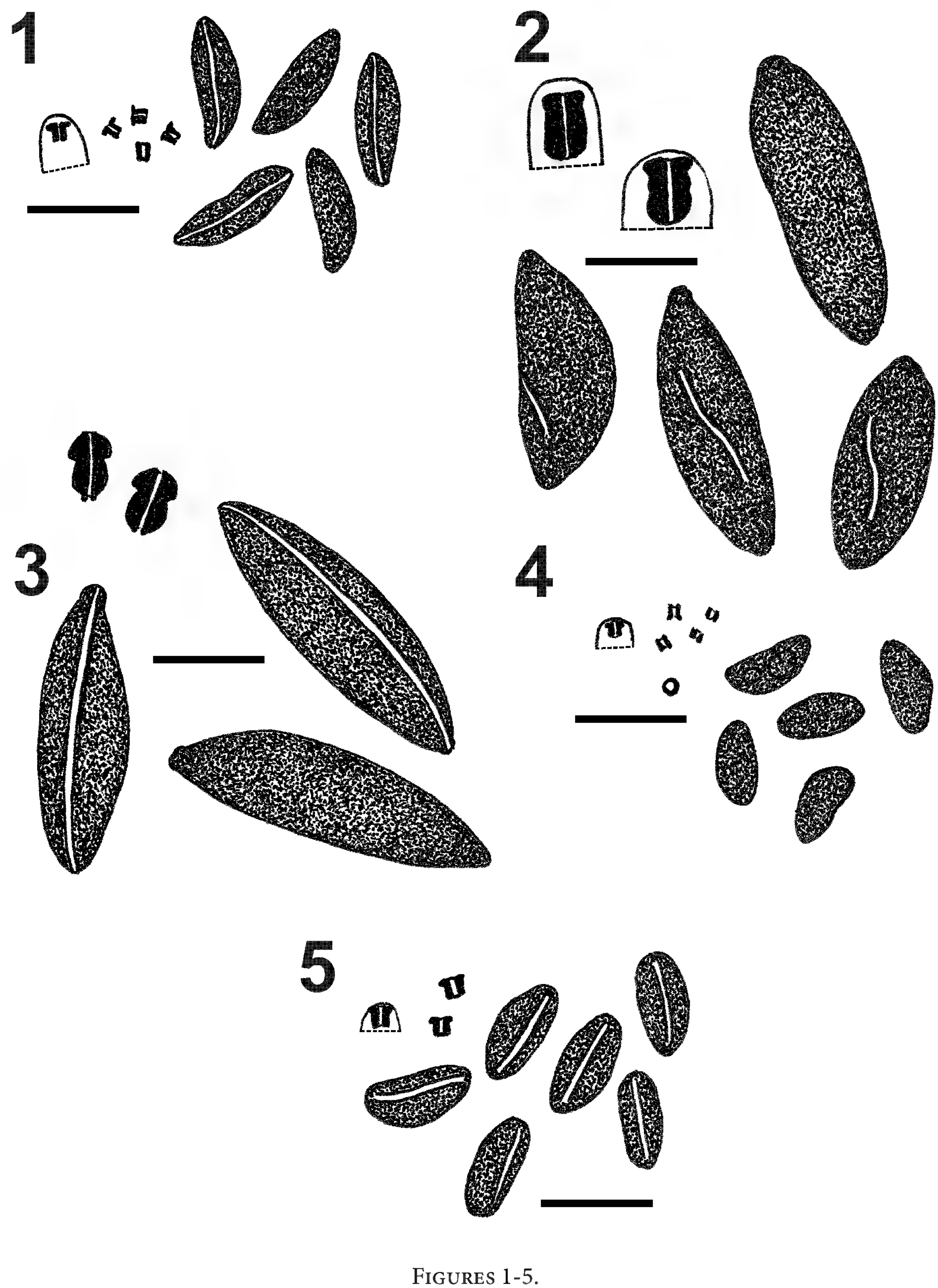
Substrate — undetermined decaying hardwood.

Material examined — **BRAZIL. Santa Catarina: Ilhota**. Morro do Baú. col. Trierveiler-Pereira. 24.X.2004 (FLOR 31916); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz**. Hotel Caldas da Imperatriz. col. Trierveiler-Pereira. 26.V.2007 (FLOR 31939).

Taxonomic remarks — The moriform fertile part and the spiraling germ slit are very characteristic of *X. anisopleura*.

Xylaria comosa (Mont.) Fr., Summa veg. Scand. Sect. Post. (Stockholm): 381 (1849) Fig. 3

Stromata with fertile part cylindrical to subglobose, apices sterile, bearing short, slender, pointed processes, unbranched, 10–15 mm total length × 6–10 mm diam, long-stipitate, stipe slender, black, velvety, 18–30 × 2–3 mm. External surface black, smooth except for whitish remnants of conidial processes, punctuated by the ostioles. Internally beige to light-brown. Perithecia completely immersed, up to 1.5 mm diam, ostioles black, discoid. Asci eight-spored, cylindrical, stipitate, the spore-bearing part 200–250 µm, apical ring



FIGURES 1-5.
1. *Xylaria adscendens*. 2. *X. anisopleura*. 3. *X. comosa*. 4. *X. cubensis*. 5. *X. curta*
(scale bars= 10 µm).

bluing in Melzer's iodine reagent, urn-shaped, 6–8 µm high × 4–6 µm broad. Ascospores ellipsoid-inequilateral with abrupt pinched ends, dark brown, unicellular, smooth, 28–38 × 7–9 µm, germ slit conspicuous, straight, running full-length of ascospore.

Substrate — undetermined decaying hardwood.

Material examined — **BRAZIL. Santa Catarina: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 07.XII.2005 (FLOR 31918); **BRAZIL. Santa Catarina: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 07.XII.2005 (FLOR 31920).

Taxonomic remarks — The examined material is typical for the species (Dennis 1956, Lloyd 1917). The ascospores have straight germ slit, as does the lectotype selected by Læssøe (1999). The species can be recognized in field by the presence of pointed processes in the apex, whitish scales in the stromatic surface and velvety stipe.

Xylaria cubensis (Mont.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 126 (1851). Fig. 4

Stromata with fertile part cylindrical, cylindrical-clavate to clavate, with rounded, fertile apices, unbranched, 1.3–2.9 cm total length × 0.9–2.5 cm diam, sessile or short-stipitated, stipe smooth, black, 0.2–0.7 cm high × 0.2–0.4 cm wide. External surface dark brown to black, smooth to slightly roughened, punctuated by the ostioles. Internally white, becoming hollow and occasionally inrolling and causing a longitudinal slit in the stroma. Perithecia completely immersed, up to 1 mm diam, ostioles black, papillate. Asci eight-spored, cylindrical, stipitate, 105–140 µm total length × 4–5 µm broad, the spore-bearing part 50–70 µm, apical ring bluing in Melzer's iodine reagent, cylindrical to quadrate, 1.5–2.5 µm high × 1.5–2.5 µm broad. Ascospores ellipsoid-inequilateral, dark olive brown, unicellular, smooth, 8.5–11 × 4–5 µm, germ slit inconspicuous.

Substrate — undetermined decaying hardwood.

Material examined — **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da Imperatriz. col. Trierveiler-Pereira & Marcon-Baltazar. 11.VII.2006 (FLOR 31929).

Taxonomic remarks — As noticed by Rogers (1984), *Xylaria cubensis* resembles *X. allantoidea* (see description of *X. allantoidea* herein), but *X. cubensis* has smaller stromata and ascospores and an inconspicuous germ slit. The germ slit is present in most *Xylaria* species and, when present, is a constant and diagnostic feature of many well-circumscribed species (Rogers 1979a). However, some species of the genus lack this feature. Another Southern Brazilian species with inconspicuous germ slit is *X. holmbergii* Speg., which differs from *X. cubensis* primarily by larger ascospores and distinct stromatic surface (Hamme & Guerrero 1994).

Xylaria curta Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 126 (1851). Fig. 5

Stromata with fertile part cylindrical-clavate, with rounded, fertile apices, unbranched, single or clustered, 1.4–1.8 cm total length × 0.4–0.6 cm diam,

short-stipitate, stipe smooth, black, 0.2–0.7 cm high × 0.1–0.3 cm wide. External surface blackish with golden brown scales, roughened and with small wrinkles. Internally white and occasionally becoming hollow. Perithecia completely immersed, up to 0.5 mm diam, ostioles black, papillate. Asci eight-spored, cylindrical, stipitate, 100–160 µm total length × 4–5 µm broad, the spore-bearing part 60–80 µm, apical ring bluing in Melzer's iodine reagent, cylindrical to inverted hat-shaped, 1.5–2.0 µm high × 1.0–1.5 µm broad. Ascospores ellipsoid-inequilateral to broad ellipsoid-inequilateral, dark brown, unicellular, smooth, 8–11 × 3.5–5 µm, germ slit conspicuous, straight, running full-length of ascospore.

Substrate — undetermined decaying hardwood.

Material examined — **BRAZIL. SANTA CATARINA: Florianópolis.** Trilha para Lagoinha do Leste. col. Trierveiler-Pereira & Marcon-Baltazar. 24.VI.2006 (FLOR 31928).

Taxonomic remarks — Dennis (1956) suggested that *Xylaria curta* could be no more than a form of *X. feejeensis* (Berk.) Fr., differing in its stouter, often sessile, and clustered habit and possession of white or cream coloured scales. Rogers (1983) accepted these two species as closely related but did not consider *X. curta* a synonym of *X. feejeensis*. *Xylaria faveolis* Lloyd is considered by Dennis (1956) to represent a synonym of *X. curta*.

Xylaria ianthinovelutina (Mont.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 128 (1851). Fig. 6

Stromata with fertile part cylindrical, branched or unbranched, solitary or clustered, with sterile apices, 3.5–12 cm total length × 1–2 cm diam, stipe tomentose, reddish brown to black, up to 4.5 cm high × 0.2 cm wide. External surface reddish brown to black, tomentose, roughened with perithecia contours. Internally white, not becoming hollow. Perithecia mammiform, naked or more less immersed, up to 0.8 mm diam, ostioles black, papillate. Asci eight-spored, cylindrical, stipitate, 90–130 µm total length × 4–6 µm broad, the spore-bearing part 70–90 µm, apical ring bluing in Melzer's iodine reagent, cylindrical, 1.5–2 µm high × 1–2 µm broad. Ascospores ellipsoid-inequilateral, brown, unicellular, smooth, 9–13 × 4–5.5 µm, germ slit conspicuous, straight, running full-length of ascospore.

Substrate — fallen fruits of *Trichilia elegans* A. Juss. (*Meliaceae*) and *Inga sessilis* (Vell.) Mart. (*Mimosaceae*).

Material examined — **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da Imperatriz. col. Trierveiler-Pereira. 13.VII.2006 (FLOR 31931); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da Imperatriz. col. Trierveiler-Pereira, Santos, Bruggeman & Galindro. 11.XI.2006 (FLOR 31933); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da

Imperatriz. col. Trierveiler-Pereira, Santos, Bruggeman & Galindro 11.XI.2006 (FLOR 31934).

Taxonomic remarks — The species usually has fruits as substrate, but there are some Southern Brazilian collections on wood (Rick 1935, Theissen 1909). In this study, one other species found on fallen fruits, *X. magnoliae* var. *microspora*, differs in having navicular, lighter ascospores and an inconspicuous germ slit. Because many *Xylaria* species specific to a single host genus or family, Rogers (1979b) emphasized the importance of the host in separating the two species, with *X. ianthinovelutina* found more frequently on leguminous fruits.

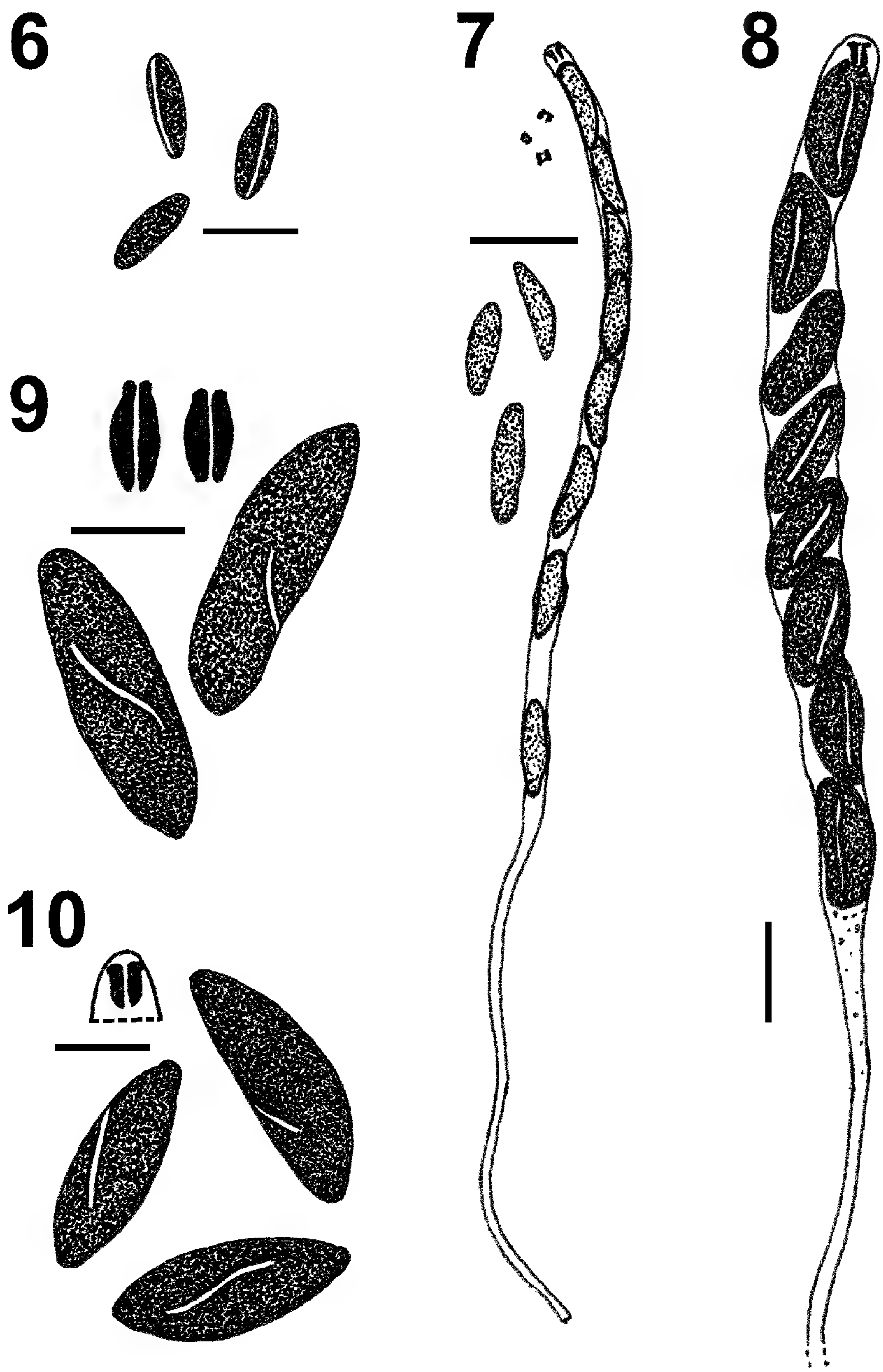
Xylaria magnoliae* var. *microspora J.D. Rogers, Y.M. Ju & Whalley, Sydowia 54(1): 96 (2002). Fig. 7

Stromata with fertile part cylindrical to irregular-cylindrical, branched or unbranched, solitary to cespitose, with sterile apices, 3.0–8.5 cm total length × 1–3 cm diam, stipe velvety to tomentose, blackish, up to 3 cm high × 0.3 cm wide. External surface blackish, tomentose, roughened with perithecia contours. Internally white, not becoming hollow. Perithecia mammiform, naked or more or less immersed, up to 0.5 mm diam, ostioles black. Asci eight-spored, cylindrical, stipitate, 104–143 µm total length × 3–4 µm broad, the spore-bearing part 59–82 µm, apical ring turning dark blue in Melzer's iodine reagent, cylindrical, 1–2 µm high × 1–1.5 µm broad. Ascospores navicular, yellowish to light-brown, unicellular, smooth, 8–11 × 2–3 µm, germ slit inconspicuous.

Substrate — fallen fruits of *Talauma ovata* A. St.-Hil. (*Magnoliaceae*).

Material examined — **BRAZIL. Santa Catarina: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira. 27.VII.2005 (FLOR 31915); **BRAZIL. Santa Catarina: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 03.XI.2005 (FLOR 31917); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da Imperatriz. col. Trierveiler-Pereira, Santos, Bruggeman & Galindro 11.XI.2006 (FLOR 31935); **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz.** Hotel Caldas da Imperatriz. col. Trierveiler-Pereira, Santos, Bruggeman & Galindro. 11.XI.2006 (FLOR 31936).

Taxonomic remarks — *Xylaria magnoliae* J.D. Rogers was described in 1979, growing on fruits of *Magnolia* L. in North America (Rogers 1979b). Rogers et al. (2002) later described specimens from Thailand with smaller ascospores (9–11 × 3–4 µm vs 11–15 × 3–5) as *X. magnoliae* var. *microspora*. We refer our material, which also has smaller ascospores, to *X. magnoliae* var. *microspora*. All specimens were collected from fallen fruits of *Talauma ovata* (*Magnoliaceae*), a very frequent tree in Atlantic Forest (Lorenzi 2002). *Xylaria liquidambaris* J.D. Rogers et al. and *X. jaliscoensis* F. San Martín et al. are also described from *Magnolia* fruits (Rogers et al. 2002). Other fruit-inhabiting species are *X. persicaria* (Schwein.) Berk. & M.A. Curtis (from *Liquidambar* L. fruits),



FIGURES 6-10.
6. *Xylaria ianthinovelutina*. 7. *X. magnoliae* var. *microspora*.
8. *X. mellissii*. 9. *X. obovata*. 10. *X. telfairii*
(scale bars= 10 μm).

X. carpophila (Pers.) Fr. (from *Fagus* L. fruits), and *X. ianthinovelutina* and *X. culleniae* Berk. & Broome (from leguminous fruits) (Rogers 1979b).

Xylaria mellissii (Berk.) Cooke, Grevillea 11(59): 85 (1883). FIG. 8

Stromata with fertile part cylindrical, conical to subclavate, with mucronate sterile apices, branched or unbranched, 0.4–1.1 cm total length × 0.9–3.9 cm diam, long to short-stipitate, stipe black, tomentose, 0.5–1.7 cm high × 0.4–1 cm wide. External surface black, with brown peeling outer layer, roughened. Internally white, not becoming hollow. Perithecia completely immersed, up to 1 mm diam, ostioles black, papillate. Asci eight-spored, cylindrical, stipitate, 125–195 µm total length × 6–7 µm broad, the spore-bearing part 75–110 µm, apical ring bluing in Melzer's iodine reagent, cylindric to inverted hat-shaped, 2.5–3 µm high × 2–2.5 µm broad. Ascospores ellipsoid-inequilateral, dark brown, unicellular, smooth, 14–17(–19) × 6–7 µm, germ slit conspicuous, straight to slightly wavy, longitudinal, less than ascospore-length.

SUBSTRATE — dead branch of *Bauhinia variegata* L. (*Leguminosae*); undetermined decaying hardwood.

MATERIAL EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis**. HORTO BOTÂNICO DA UFSC. col. Trierveiler-Pereira. 06.III.2006 (FLOR 31924); **BRAZIL. SANTA CATARINA: Santo Amaro da Imperatriz**. HOTEL CALDAS DA IMPERATRIZ. col. Trierveiler-Pereira & Marcon-Baltazar. 11.VII.2006 (FLOR 31930).

TAXONOMIC REMARKS — Dennis (1961) treated *X. arbuscula* Sacc. as a synonym of *X. mellissii*. *Xylaria mellissii* is very similar to *X. apiculata* Cooke, which, however, has longer (≤ 25 µm) ascospores (Rogers & Samuels 1986). *X. pseudoapiculata* Hamme & Guerrero, described from Southern Brazil, which is also macroscopically similar to *X. mellissii*, has a spiraling germ slit (Hamme & Guerrero 1997). Another species with mucronate apices from Southern Brazil is *X. euphorbiicola* Rehm, which is distinguished by a smooth surface, slender stipe, and 8–10 µm long ascospores (Dennis 1957).

Xylaria nigromedullosa Trierveiler-Pereira & A.I. Romero, **sp. nov.** FIG. 11-13

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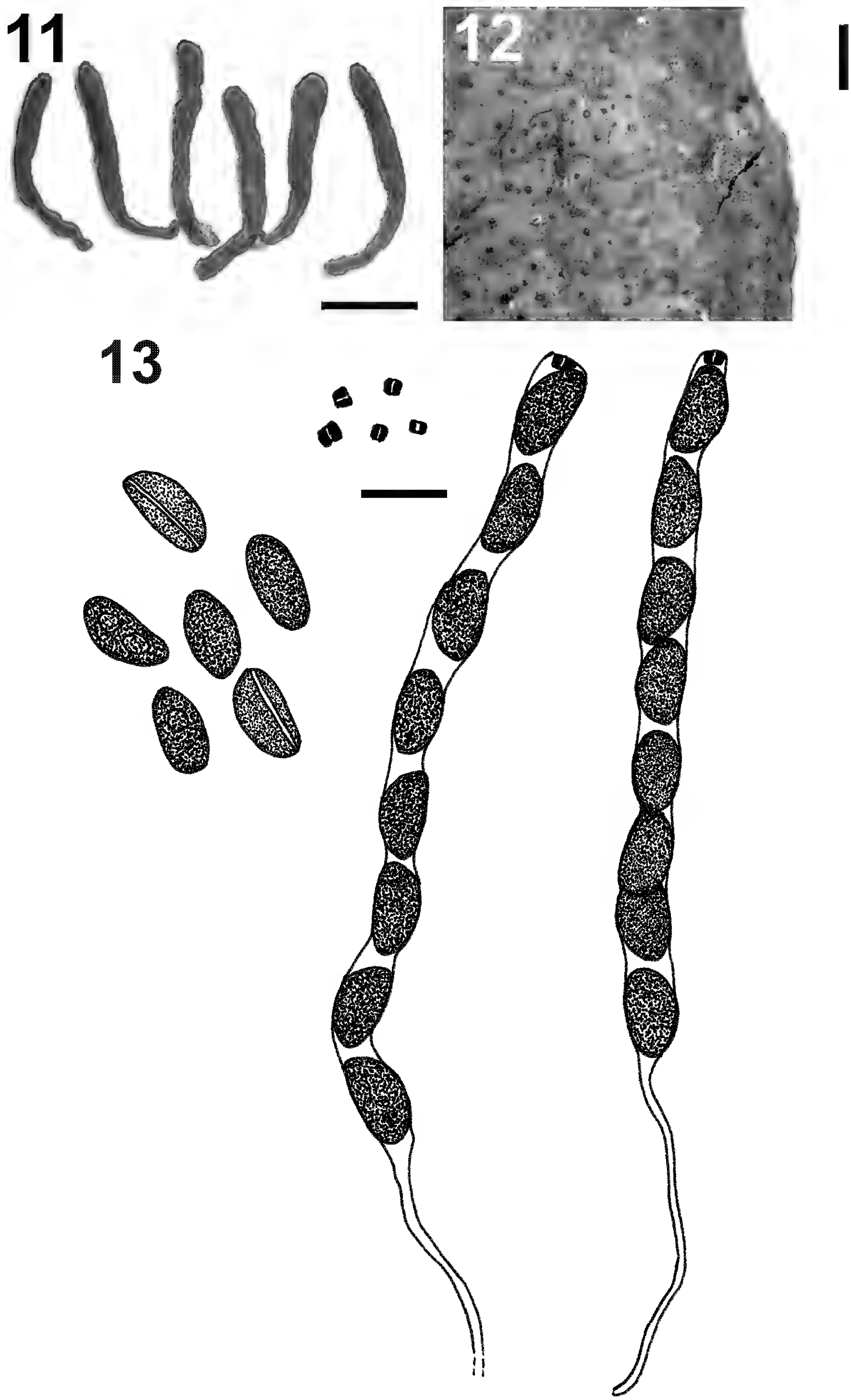
Stromata cylindracea vel cylindricea-clavata, apicibus rotundatis fertilibus, non ramosa, 3.6–5.2 × 0.4–0.7 cm, stipite glabro,1.3–2.7 × 0.2–0.4 cm. Extus brunneae vel nigra, asperata ab formis peritheciorum et papillis ostiolorum, intus nigra. Peritheciis omnino immersis, usque 0.5 mm diam, ostiolo nigro papillato. Asci octospori, cylindrici, stipitati, 122–140 longitudine tota × 6–8 µm crassi, partibus sporiferis 79–93 µm, annulo apicali in liquore Melzeri cyanescente, cylindrici vel quadrato, 1–2.5 µm alto × 1–2 µm crasso. Ascosporae late ellipsoideo-inequilaterales, brunneae vel fuliginosae, unicellulares, leves, 7–9.5 × 4–5 µm, rima germinative recta per longitudinem sporae.

HOLOTYPUS — *Brasilia, Santa Catarina, Florianópolis, U.C.A.D., ad lignum emortuum in silva, legit Trierveiler-Pereira & Marcon-Baltazar, 07.XII.2005 (FLOR 31941).*

ETYMOLOGY — the epithet refers to the characteristically black entostroma.



Figures 11-13. *Xylaria nigromedullosa*.
11. Stromata (scale bar = 3 cm). 12. Detail of ectostroma and ostioles (scale bar = 2 mm).
13. Ascospores, apical rings and asci (scale bar = 10 µm).

Stromata with fertile part cylindrical to cylindrical-clavate with rounded fertile apex, unbranched, 3.6–5.2 cm total length × 0.4–0.7 cm diam. Stipe smooth, long narrowed, 1.3–2.7 cm length × 0.2–0.4 cm diam. External surface dark brown to black, rugose by perithecial contours, with small wrinkles. Internally intense black, fibrous, not becoming hollow. Perithecia completely immersed, up to 0.5 mm diam, ostioles papillate, black. Asci eight-spored, cylindrical, stipitate, 122–140 µm total length × 6-8 µm broad, the spore-bearing part 79–93 µm long, with apical ring bluing in Melzer´s iodine reagent, cylindrical, quadrate to inverted hat-shaped, 2–2.5 µm high to 2–2.5 µm broad. Ascospores broadly ellipsoid-inequilateral, very dark brown, nearly black, unicellular, smooth, 7–9.5 × 4–5 µm, germ slit straight, running full-length of ascospore, very difficult to observe.

SUBSTRATE — undetermined decaying hardwood.

MATERIAL EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 07.XII.2005 (FLOR 31941 - holotype).

TAXONOMIC REMARKS — The presence of a black entostroma is unusual within *Xylaria*. Other species that can be internally black include *X. berkeleyi* Mont. and the termite nest fungi *X. nigripes* (Klotzsch) Sacc., *X. escharoidea* (Berk.) Fr., and *X. furcata* Fr. (J.D. Rogers, pers. comm.). *X. berkeleyi* has larger, ellipsoid-inequilateral ascospores (13–15 µm) with a germ slit much shorter than full-length (Rogers et al. 1988). The termite nest fungi have distinct stromata and much smaller ascospores (Rogers et al. 2005). San Martín & Rogers (1989) described *X.* cf. *longiana* Rehm & *X. multiplex* (Kunze) Fr. with black entostroma. These two species have ascospores that are similar in size to that described for *X. nigromedullosa*, but the species are macroscopically very distinct. Hladki & Romero (2007) described *X. fissilis* Ces. and *X. luxurians* (Rehm) Lloyd as having dark brown to black entostroma but differing from *X. nigromedullosa* in stromatic features, ascospores size, and germ slit.

Xylaria obovata (Berk.) Fr., Nova Acta Regia Soc. Sci. Upsal., Ser. 3, 1: 127 (1851). FIG. 9

Stromata with fertile part subglobose, irregular-cylindrical to reniform, with rounded fertile apex, 9–17 mm total length × 8–8.5 mm cm diam, short-stipitate. Stipe smooth, 3–6 mm length × 2–3 mm diam. External surface black, smooth to wrinkled. Internally white to cream, occasionally becoming hollow. Perithecia black, completely immersed, up to 1 mm diam, ostioles papillate, black. Asci eight-spored, cylindrical, stipitate, 135–176 µm total length × 7–9 µm broad, the spore-bearing part 95–120 µm long, with apical ring bluing in Melzer's iodine reagent, 6–10 µm high to 4–5 µm broad. Ascospores ellipsoid-

inequilateral, grayish-black, unicellular, smooth, (25–)27–35 × 7–9 µm, germ slit conspicuous, oblique, wavy, less than ascospore length.

SUBSTRATE — undetermined decaying hardwood.

MATERIAL EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira. 2004 (FLOR 31914).

TAXONOMIC REMARKS — Obovate stromata characterize this species (Dennis 1970, Lloyd 1917), but the examined material does exhibit other stromatic shapes. The ascospores size is similar in many descriptions (Callan & Rogers 1990, Lloyd 1917, Rogers et al. 1988, Theissen 1909, Viégas 1944). Callan & Rogers (1990) described the germ slit as straight, but our material has ascospores with an oblique germ slit, also noted by Rogers et al. (1988). *Xylaria obovata* is member of the *X. polymorpha* complex (Dennis 1956, Ju & Rogers 1999).

Xylaria telfairii (Berk.) Sacc., Syll. fung. (Abellini) 1: 320 (1882). FIG. 10

Stromata robust, with fertile part clavate to cylindrical, with rounded fertile apices, unbranched, solitary, rarely gregarious, 2.3–8.9 cm total length × 1.1–2.4 cm diam. Stipe black, 2.1–3.1 cm length × 0.4–0.8 cm diam. External surface copper, cinnamon to light brown, smooth, punctuated by the ostioles. Internally white to cream, becoming hollow and inrolling. Perithecia completely immersed, up to 1 mm diam, ostioles umbilicate, black. Asci eight-spored, cylindrical, stipitate, 180–215 µm total length × 7–8 µm broad, the spore-bearing part 100–135 µm long, with apical ring bluing in Melzer's iodine reagent, urn-shaped to inverted hat-shaped, 4–4.5 × 3–4.2 µm. Ascospores ellipsoid-inequilateral, dark brown, unicellular, smooth, 19–26(–29) × 7–8 µm, germ slit conspicuous, oblique, wavy, less than ascospore-length.

SUBSTRATE — undetermined decaying hardwood.

MATERIAL EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 03.XII.2005 (FLOR 31919); **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. col. Trierveiler-Pereira & Marcon-Baltazar. 07.XII.2005 (FLOR 31923); **BRAZIL. SANTA CATARINA: Ilhota.** MORRO DO BAÚ. Mozerle. 22.III.2006 (FLOR 31925); **BRAZIL. SANTA CATARINA: Florianópolis.** HORTO BOTÂNICO DA UFSC. Rosa. 27.III.2006 (FLOR 31926); **BRAZIL. SANTA CATARINA: Florianópolis.** U.C.A.D. Santos. 24.IV.2006 (FLOR 31927).

TAXONOMIC REMARKS — The examined material is typical for the species. One collection (FLOR 31925) differs from typical *X. telfairii* in having a grayish stromatal surface. Dennis (1956) considered *X. enterogena* (Mont.) Fr., *X. tabacina* (J. Kickx f.) Berk., and *X. wrightii* Berk. & M.A. Curtis synonyms of *X. telfairii*. Rogers et al. (1988), however, considered *X. telfairii* and *X. enterogena* distinct species, with *X. enterogena* distinguished by a yellow-white color and smaller stature and ascospores.

Discussion

Although *Xylaria* is considered one of the best-known genera in the family, nearly 65 new species of *Xylaria* have been described during the past 20 years, 25 of which have been described since the year 2000.

Prior to our survey, 19 *Xylaria* species were recorded from Santa Catarina State, primarily from in the northern region, which may explain why we did not re-collect some species. *Xylaria adscendens*, *X. allantoidea*, *X. anisopleura*, *X. comosa*, *X. cubensis*, *X. curta* and *X. mellissii* represent new records for the State, and *Xylaria magnoliae* var. *microspora* represents the first record from Brazil.

Our data show the importance of continuous studies on the genus, especially in the tropics, where *Xylaria* diversity is very high.

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Lecanora weii, a new multispored species of *Lecanora* s. str. from northeastern China

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Abstract––A new multispored species of *Lecanora* containing usnic acid, *L. weii* is described as new to science. A key to the four known multispored species of *Lecanora* in China is also provided.

Key words––*Ascomycota*, flora of China, lichens, pruinose discs

Introduction

Lecanora is characterized by asci of the *Lecanora*-type, simple ascospores, and crustose thalli. The taxa of *Lecanora* grow on a wide variety of substrata, such as rocks, soil, bark or wood. The multispored taxa share the characteristics in anatomy and chemistry with the majority of species within *Lecanora* sensu stricto and belong to what is commonly referred to as the *Lecanora subfusca* group (Brodo 1984, Lumbsch 1994). They only differ in having more than eight spores per ascus, and appear to be polyphyletic in origin (Guderley & Lumbsch 1999).

The multispored species group of *Lecanora* includes six species worldwide: *L. bruneri* Imshaug & Brodo, *L. cateilea* (Ach.) A. Massal., *L. japonica* Müll. Arg., *L. pleospora* Müll. Arg., *L. praesistens* Nyl., and *L. sambuci* (Pers.) Nyl. The characters of these multispored species have been discussed in detail by Imshaug & Brodo (1966), Miyawaki (1988), and Purvis et al. (1992). Guderley & Lumbsch (1999) specifically studied the multispored species to clarify the relationship of the multispored species to members of *Lecanora* sensu stricto.

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In China, Wei (1991) enumerated 63 species, 11 varieties and 5 forms of *Lecanora*, although not including any multispored species. An additional 12 eight-spored species have been reported since 1991 (Cao et al. 1995, Abbas & Wu 1998, Aptroot & Seaward 1999, Mamut et al. 2004). Three multispored species of *Lecanora* (*L. bruneri*, *L. cateilea*, and *L. japonica*) were reported by Wang et al. (2007).

During the study of *Lecanora* from China, we discovered a species new to science. We provide here general data on habitat, diagnostic characters, geographic distribution of the new species and a key for the identification of the four known multispored species of *Lecanora* in China.

Materials and methods

The present paper is based on collections from the Herbarium Mycologicum Academiae Sinicae-Lichenes (HMAS-L). All the specimens were examined and measured under a dissecting microscope (Motic SMZ-140) and compound microscope (Olympus CH). The anatomy of the apothecia was observed in free-hand sections mounted in water. The crystals in the apothecia described are only those visible in polarized light (under Motic PM18). For a more detailed study of discs, a scanning electron microscope (Hitachi S-570) was used. Secondary metabolites were identified using thin-layer chromatography (TLC) (Culberson 1972).

Results and discussion

Key to the multispored species of *Lecanora* in China

1a. Apothecial discs epruinose; epihymenium egranulose,
spores 7.5–12.5 × 4.0–7.0 µm .... ***L. japonica***

1b. Apothecial disc pruinose, epihymenium granulose.......................... 2

2a. Apothecial sections P– (lacking psoromic acid, but containing usnic acid);
ascospores 12.0–14.5 × 6.0–8.5 µm ....***L. weii***

2b. Apothecial sections P+ yellow (psoromic acid present, usnic acid absent);
ascospores 6.5–12.0(–13.0) × (3.5–)5.0–7.5 µm 3

3a. Apothecia densely clustered; apothecial margins thick, persistent;
ascospores 12–16 per ascus ....***L. bruneri***

3b. Apothecia abundant but scattered, apothecial margins usually thin;
ascospores 8–12 per ascus ....***L. cateilea***

Taxonomic description

Lecanora weii L.F. Han & S.Y. Guo, **sp. nov.** FIG. 1A–C

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Thallus crustaceus, tenuis, cinereus, tartareus, continuus. Prothallus nigrofuscus. Soredia nulla. Apothecia sessilia vel ad basin constricta, 0.4–1.5 mm in diametro. Disci rubrofusci,

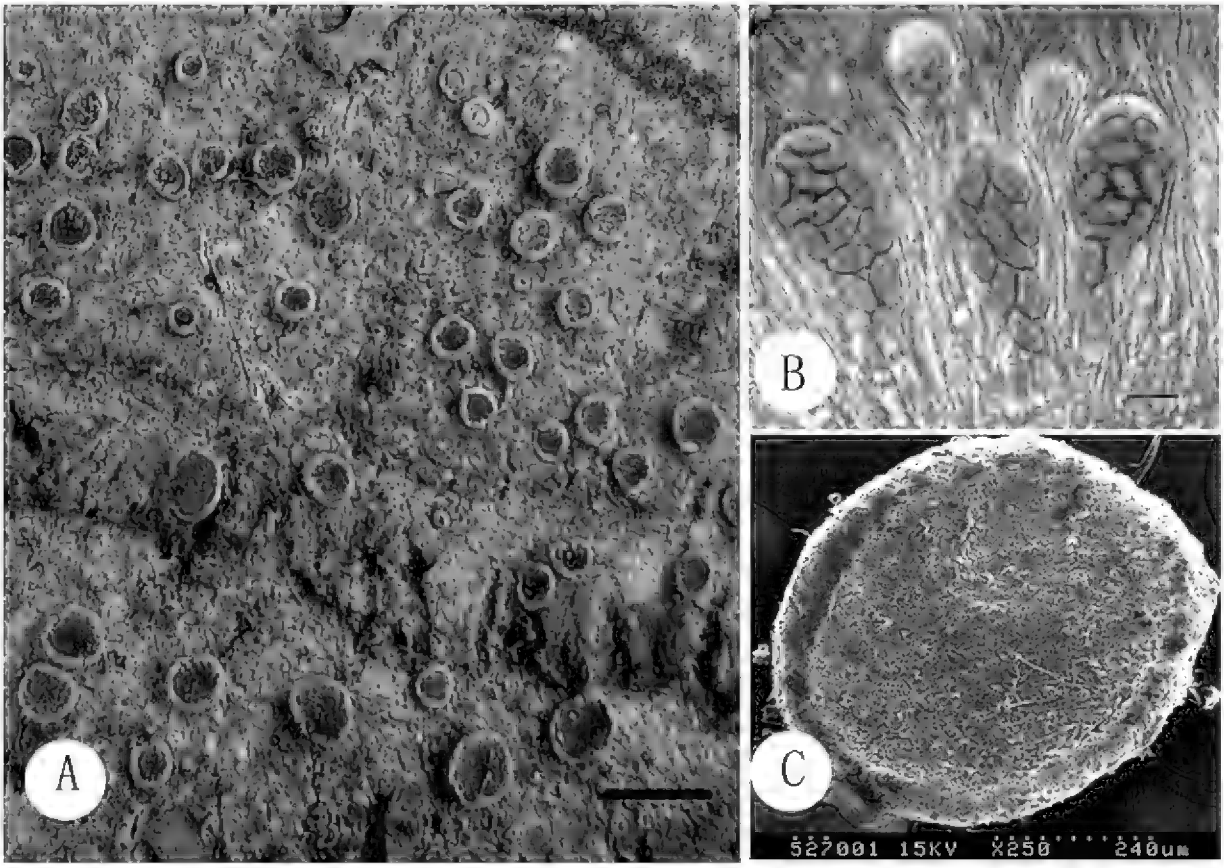

FIG. 1 Habit of *Lecanora weii*. A. Thallus with numerous apothecia. Scale = 2 mm. B. Section through apothecium (stained by 2%Toluidine blue about 30 min before adding 10% KOH), showing multispored asci and paraphyses. Scale = 15 µm. C. SEM photograph, showing pruina on the apothecial disc. Scale = 240 µm.

pruinosi. Margo thallinus albidus, integer. Cortex indistinctus, 2–5 µm. Amphithecium crystalla minuta continens. Epihymenium rubrofuscum, granulosum, ca. 10–20 µm altum. Hymenium hyalinum, 60–80 µm altum. Hypothecium et subhymenium hyalinum, 30–50 µm altum. Asci clavati, 12–16 spori. Ascosporae hyalinae, simplices, 12.0–14.5 × 6.0–8.5 µm. Pycnidia non visa. Thallus atranorinum, acidum usnicum et alium continens.

ETYMOLOGY: This species is named in honor of Prof. Jiang-chun Wei (Beijing), the collector of the type specimen and a distinguished lichenologist, who as author of numerous papers and books on lichenology is regarded as "the father of lichenology in China". It also expresses our deepest gratitude for his encouragement and support in our *Lecanora* studies.

HOLOTYPE: CHINA. Heilongjiang. Mt. Dailing, Liangshuilinchang (Liangshui forest farm), alt. 350 m, on bark, 1975 V 8, Wei Jiang-Chun 2139 (HMAS-L 75828-1, holotype).

THALLUS crustose, thin, continuous, coarse to slightly areolate, pale gray to gray, esorediate, epruinose, often with a black prothallus. APOTHECIA abundant, often single, sessile to constricted at the base, 0.4–1.5 mm in diam., disc red brown to dark brown, slightly to heavily pruinose, concave to plane, margins thin, prominent, smooth, entire, concolorous with thallus (FIG. 1A & 1C). AMPHITHECIUM: cortex thin 2–5 µm laterally, 5–10 µm basally; algal layer 40–65 µm laterally, 60–120 µm basally, containing numerous small KOH-

insoluble crystals. Epihymenium orange brown, with coarse crystals, which dissolve KOH and HNO_3, 10–20 µm tall. Hymenium hyaline, 60–80 µm tall, subhymenium colorless, 10–20 µm tall, hypothecium colorless, 20–25 µm tall, paraphyses not thickened or slightly thickened apically. Asci clavate, 12–16 spored. Ascospores ellipsoid to broadly ellipsoid, colorless, simple, 12.0–14.5 × 6.0–8.5 µm (Fig. 1b). Pycnidia not seen.

Chemistry—Thallus K+ yellow, KC+ yellow; containing atranorin, usnic acid and unknown substances.

Distribution and substrate—At present, *L. weii* is known only from the type locality, and nearby regions in northeastern China; on bark.

Additional specimens examined—CHINA. Heilongjiang, Mt. Dailing, alt. 350 m, 1975 X 5, J.C. Wei 2139 (HMAS-L 75828-1); alt. 400 m, 1975 X 6, J.C. Wei 2160-2 (HMAS-L 45663-2); Jilin, Mt. Changbai, alt. 840 m, 1984, X.D. Lu 848131-1 (HMAS-L 76108-1).

Comments—This species is readily distinguished by its heavily pruinose apothecial discs, numerous small KOH-soluble crystals in the amphithecium and the presence of usnic acid. *Lecanora weii* is similar to *L. cateilea* in having multispored asci and pruinose apothecial discs, but the latter is distinguished by containing psoromic acid and zeorin and lacking usnic acid (Guderley & Lumbsch 1999, Wang et al. 2007). *Lecanora sibirica* Müll. Arg. agrees with *L. weii* in containing usnic acid and also has heavily pruinose apothecial discs. The species, however, is readily distinguished by 8-spored asci and the presence of zeorin (Lumbsch et al. 1997). At present, *L. weii* is the only multispored species containing usnic acid.

Acknowledgements

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A phylogenetic analysis of *Melanelia tominii* and four new records of brown parmelioid lichens from China

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Abstract –– The molecular analysis based on ITS nrDNA sequences indicates that *Melanelia tominii* probably belongs to *Melanelixia*. Four new records from China — *Melanelia predisjuncta*, *Melanohalea subelegantula*, *M. olivaceoides*, and *M. septentrionalis* — are reported. A key to the 21 species belonging to *Melanelixia*, *Melanohalea* and *Melanelia* from China is provided.

Keywords –– Asia, taxonomy, gyrophoric acid

Introduction

The lichen genus *Melanelia* (*Parmeliaceae*) was originally established by Esslinger in 1978. Two more genera, *Melanelixia* O. Blanco et al. and *Melanohalea* O. Blanco et al., were subsequently split from *Melanelia*, based on molecular as well as chemical and morphological data (Blanco et al. 2004). *Melanelixia* is characterized by having a pored or fenestrate epicortex, by lacking pseudocyphellae and by containing lecanoric acid as the primary medullary constituent (Blanco et al. 2004, Esslinger 1977). *Melanohalea* is characterized by pseudocyphellae, often on warts or isidial tips, by a non-pored epicortex, and by a medulla containing depsidones or lacking secondary compounds (Blanco et al. 2004, Esslinger 1977). The placement of the type species of *Melanelia*, *M. stygia* (L.) Essl., outside the parmelioid lichens was strongly supported in the molecular systematic studies (Blanco et al. 2004). Although *Melanelia tominii* resembles *M. stygia* morphologically, the former species contains the tridepside gyrophoric acid (usually with other tridepsides as well), and the latter contains

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the β-orcinol depsidones fumarprotocetraric and protocetraric acid (Esslinger 1977, 1992). Because molecular sequences were not available for *M. tominii*, its systematic position remained uncertain (Blanco et al. 2004).

Worldwide, *Melanelixia* includes nine known species, *Melanohalea* nineteen species and *Melanelia* still contains a heterogeneous residue of seventeen species (Esslinger 1977, 1978, 1987, 1992; Ahti et al. 1987, Egan 1987, Galloway & Jørgensen 1990, Thell 1995, Divakar et al. 2001, 2003; Blanco et al. 2004, Divakar & Upreti 2005, Wang et al. 2008). In China, *Melanelixia* includes seven species, *Melanohalea* five species and *Melanelia* five species (Wei 1991, Abbas & Wu 1998, Kurokawa & Lai 2001, Zibirnisa et al. 2004, Chen & Esslinger 2005, Wang et al. 2008).

During our study of these genera in China, four new records were discovered, namely *Melanelia predisjuncta*, *Melanohalea subelegantula*, *M. olivaceoides* and *M. septentrionalis*, and the systematic position of *M. tominii* was investigated based on its ITS sequences (including ITS1, 5.8S nrDNA and ITS2) and morphological and chemical characters. In addition, a key to 21 species belonging to *Melanelixia*, *Melanohalea* and *Melanelia* in China is provided.

Materials and methods

Morphology and Chemistry

The specimens studied are housed in HMAS-L (Lichen Section, Herbarium of the Institute of Microbiology, Academia Sinica) unless otherwise indicated. The morphology of the lichen specimens was examined using a Zeiss stereo microscope (Stemi SV 11) and Zeiss compound microscope (Axioscop 2 plus).

TABLE 1. Specimens of *Melanelia tominii* in which the morphology, chemistry or ITS sequences were studied.

Herbarium accession #	Specimen information	GenBank accession #
114000	CHINA. Hebei, Mt. Wulingshan, alt. 1750m, on rock, T. Zhang & H.Y. Wang, WLS||042, May 17, 2004.	EU784154
036389	CHINA. Inner Mongolia, Mt. Arxan, alt. 1600m, on rock, J.C. Wei et al., Aer192, August 2, 2002.	EU784155
071058	CHINA. Inner Mongolia, Bairin Youqi, alt. 1800m, on rock, J.B. Chen & G.R. Hu, 21423, August 27, 2001.	EU784156
029902	CHINA. Sichuan, Mt. Gongga, alt. 3300m, on rock, X.Y. Wang et al., 8987, July 26, 1982	—
007086	CHINA. Hebei, Mt. Xiaowutaishan, alt. 2800m, on rock, J.C. Wei, 2042, August 16, 1964.	—
007087	CHINA. Tibet, Mt. Qomolangma, alt. 5000m, on rock, J.C. Wei & J.B. Chen, 1332, June 2, 1966.	—
077822	CHINA. Tibet, Chayu County, alt. 4250m, on rock, J.J. Su, 4801, September 26, 1982.	—
080967	U.S.A. Arizona, Cochise County, alt. 1830m, on rock, T.L. Esslinger, 12261, January 10, 1992.	—

Lichen substances in all specimens cited were identified using the standardized thin layer chromatography techniques (Culberson 1972). Information on the specimens of *M. tominii* studied is shown in Table 1.

Molecular systematics

Taxon sampling — Sequence data of the ITS nrDNA of *M. tominii* were obtained from three specimens (Table 1). Fifteen sequences of other related taxa were downloaded from GenBank (Table 2). *Lecanora leptyrodes* and *L. rupicola* were used as outgroup.

Table 2. Species and ITS sequences downloaded from GenBank.

Species	GenBank acc. #	Species	GenBank acc. #
Melanelia disjuncta	AY611077	*Melanohalea elegantula*	AY611094
M. hepatizon	AF451776	*M. exasperata*	AY611081
M. stygia	AY611121	*M. olivacea*	AY611091
		M. septentrionalis	AY611093
Melanelixia fuliginosa	AY611088	*M. subelegantula*	AY611115
M. glabra	AY611114	*M. subolivacea*	AY611123
M. subargentifera	AY611098	*Lecanora rupicola*	DQ451666
M. subaurifera	AY611099	*L. leptyrodes*	AY541255

PCR amplification and sequencing — Total DNA was extracted by the modified CTAB method (Rogers and Bendich 1988). DNA extracts were used for PCR amplification of the ITS nrDNA with ITS1 (White et al. 1990) and 1R (tatgcttaagttcagcgggt) as primers. PCR reactions were performed in a DNA Thermal Cycler (Biometra) as follows: initial denaturation at 95°C for 3 min, followed by 35 cycles of 30 s denaturation at 94°C, 45 s annealing at 58°C, 1 min extension at 72°C, and completed with a final 8 min extension at 72°C. Products were purified with Gel Extraction Mini Kit (SABC). Sequencing reactions were carried out by Shanghai Genecore Corp. with an ABI 3700 Sequencer. Both complementary strands of each sample were sequenced.

Data analysis —The alignment was analyzed using the programs ClustalX 1.8.1. The aligned ITS matrix was edited manually and the flanking regions of the small subunit and large subunit rDNA were deleted through software MEGA 4 (Tamura et al. 2007). Phylogenetic analyses were conducted also in MEGA4. The phylogenetic tree was inferred using the Minimum Evolution method (Rzhetsky & Nei 1992), of which the reliability was tested by 1000 bootstrap replications (Felsenstein 1985). The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura et al. 2004). All positions containing alignment gaps and missing data were eliminated only in pairwise sequence comparisons (Pairwise deletion option).

The phylogenetic analysis of *Melanelia tominii*

Melanelia tominii (Oxner) Essl., Lichenologist 24(1): 17 (1992)
≡ *Parmelia tominii* Oxner, Zh. Bio.-Bot. Tsyklu, Kyev 1933(7–8): 171 (1933)
= *Parmelia substygia* Räsänen, Lichenes Fenniae Exs. 51 (1935)
≡ *Melanelia substygia* (Räsänen) Essl., Mycotaxon 7: 47 (1978)
= *Parmelia borisorum* Oxner, Bot. Zh., Kyyiv 1: 33 (1940)
= *Parmelia saximontana* R.A. Anderson & W.A. Weber, Bryologist 65: 236 (1963)
= *Parmelia altaica* Oxner, Ukr. bot. Zh. 27(2): 176 (1970)

ITS PHYLOGENETIC ANALYSIS — There were a total of 501 positions in the final dataset of ITS sequences. Six *Melanohalea* species, four *Melanelixia* species and four *Melanelia* species are included in the inferred tree based on ITS (FIG.1). All the *Melanohalea* species formed a monophyletic clade supported by 83% bootstrap value. All the *Melanelixia* species clustered in a clade supported by 70% bootstrap value. *Melanelia stygia* and *M. hepatizon* formed a monophyletic clade supported by 99% bootstrap value. The *Melanohalea* clade, the *Melanelixia* clade and *Melanelia disjuncta* form a large clade supported by 92% bootstrap value, while the clade comprised of *M. stygia* and *M. hepatizon* becomes the outgroup of the former three clades. Although *M. disjuncta* clustered in a clade together with *Melanohalea*, the clade has low bootstrap support (<50%) so the placement of *M. disjuncta* remains uncertain. These results are consistent with previous analyses based on polygenes (Blanco et al. 2004, Thell et al. 2002). In our study, *Melanelia tominii* 1 represents a specimen from Mt. Wuling, Hebei Province, China (herbarium accession no. 114000). *M. tominii* 2 represents two specimens from Inner Mongolia Province, China (herbarium accession nos. 036389, 071058), for which the ITS sequences are identical. *M. tominii* 1 and *M. tominii* 2 form a clade supported by 100% bootstrap value. Within the *Melanelixia* clade (70% bootstrap value), *M. tominii* and the interior clade comprised of *Melanelixia fuliginosa* and *M. subaurifera* (99% bootstrap value) form a moderately supported clade (58% bootstrap value), while another interior clade comprised of *M. glabra* and *M. subargentifera* (100% bootstrap value) becomes the outgroup of the three former clades. The fact that *M. tominii* locates within the *Melanelixia* clade in the phylogenetic tree, strongly indicates that *M. tominii* belongs to *Melanelixia* rather than *Melanelia*.

MORPHOLOGY AND CHEMISTRY — *Melanelia tominii* was included in the nominal subgenus *Melanelia* (Esslinger 1978) together with *M. stygia*, *M. disjuncta*, *M. panniformis*, *M. predisjuncta*, and *M. sorediata*. The rather small, dark, narrow lobed saxicolous thalli with the effigurate pseudocyphellae distinguish the members of this group from all the other species previously included in *Melanelia*. Further, both *M. stygia* and *M. tominii* have cylindrical to bifusiform conidia. However, *M. stygia* is chemically unique in this group by containing the β-orcinol depsidones (fumarprotocetraric and protocetraric

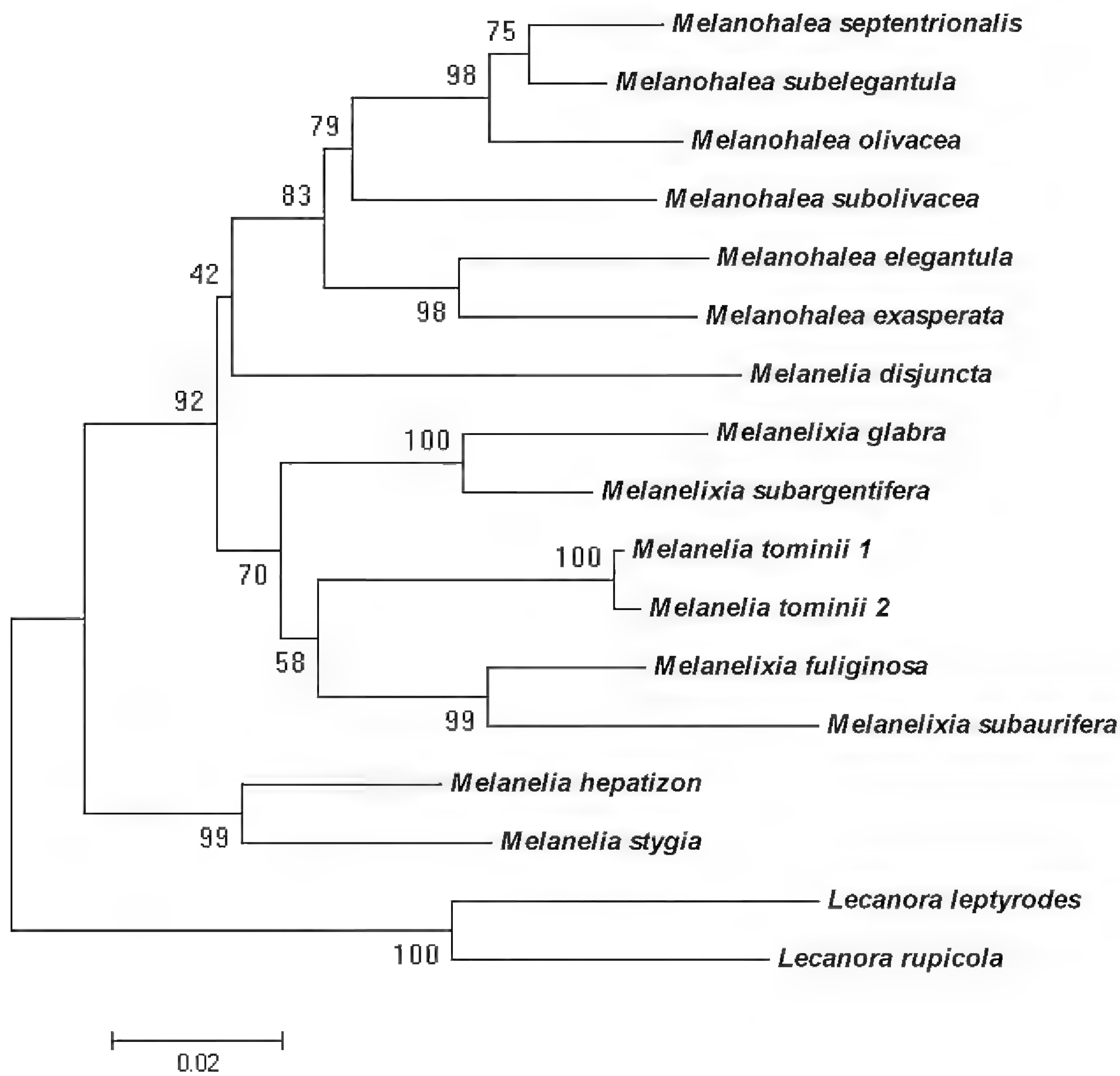

Fig. 1 The ME tree inferred from ITS data. The bootstrap values (1000 replicates) are shown next to the branches.

acids), while five of the other species contain orcinol *para*-depsides. *M. tominii* contains the tridepside gyrophoric acid, while *M. disjuncta*, *M. panniformis*, *M. predisjuncta*, and *M. sorediata* contain the depsides, perlatolic and stenosporic acids. The molecular analysis indicates that *M. disjuncta* and *M. tominii* are phylogenetically quite distant from *M. stygia*, but are closely related to *Melanelixia* and *Melanohalea* (Fig.1). *Melanohalea* species contain β-orcinol depsidones (six species contain fumarprotocetraric acid and one species norstictic acid) or lack lichen substances, while *Melanelixia* species contain the orcinol *para*-depside, lecanoric acid. Lecanoric and gyrophoric acids are closely related chemically as both derive from orsellinic acid moieties: the former is derived from two molecules of orsellinic acid, while the latter is derived from three. Thus *M. tominii* is also chemically similar to *Melanelixia*. In addition to *Melanelia tominii*, *M. microglabra*, *M. calva*, *M. fuscosorediata*,

M. glabratuloides, *M. piliferella*, *M. pseudoglabra*, and *M. subglabra* also produce gyrophoric acid as a major constituent (Esslinger 1977, Divakar et al. 2003). *M. tominii* is widely distributed in the northern hemisphere, and *M. microglabra* is known only from the type specimen in India, while the other six species are restricted to the Southern Hemisphere. As originally circumscribed (Esslinger 1978), the genus *Melanelia* comprised 46 species. The eight species with cortical hairs are now considered to belong to *Melanelixia* or the group containing gyrophoric acid, e.g. *M. fuscosorediata*, *M. piliferella*, and *M. pseudoglabra*. This evidence indicates that the species containing gyrophoric acid probably belong to *Melanelixia*, and the generic concept may be amended accordingly.

However, neither *M. tominii* nor the *Melanelia* species containing gyrophoric acid are transferred formally to *Melanelixia* in this paper, because of the paucity of our molecular data.

New records

1. *Melanelia predisjuncta* (Essl.) Essl., Mycotaxon 7(1): 47 (1978)
≡ *Parmelia predisjuncta* Essl., J. Hattori bot. Lab. 42: 50 (1977)

This species is characterized by the saxicolous habit, the narrow lobes (0.4–0.8 mm broad), the presence of pseudocyphellae, the lack of isidia and soredia, the acerose to slightly bifusiform conidia, the common apothecia, the black lower surface, the moderate rhizines, and the presence of perlatolic and stenosporic acids in the medulla (K–, C–, KC–, PD–). *M. predisjuncta* is superficially similar to *M. stygia*, but *M. stygia* can be readily distinguished by the more regular and distinctive pseudocyphellae, the bifusiform conidia, the thicker upper cortex (30–50 µm cf. 8–12 µm), and the absence of perlatolic and stenosporic acids. Of the three other species containing perlatolic and stenosporic acids, namely *M. disjuncta*, *M. sorediata* and *M. panniformis*, the former two have soralia, and the third species has distinctive laminal lobules. In our study only one specimen of *M. predisjuncta* was found. The specimen lacks apothecia, its upper cortex is 8–10 µm thick, lower cortex 9–12 µm thick and lobes 90–110 µm thick.

M. predisjuncta has been reported from Japan (Esslinger 1977) and Russia (Makryi 1981). New to China.

Specimen examined: CHINA. **Jilin**, Hongtoushan, Mt. Changbaishan, alt. 1900 m, on rock, J.C. Wei & J.B. Chen 6251 (HMAS-L: 052098).

2. *Melanohalea subelegantula* (Essl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 883 (2004)
≡ *Parmelia subelegantula* Essl., J. Hattori bot. Lab. 42: 89 (1977)
≡ *Melanelia subelegantula* (Essl.) Essl., Mycotaxon 7(1): 48 (1978)

This species is characterized by the typically corticolous habit, the moderate lobes (1–3 mm broad), the lack of pseudocyphellae, soredia and pycnidia, the

rare apothecia, the black lower surface, the moderate rhizines, the absence of lichen substances (K–, C–, KC–, PD–), and the distinctive, small isidia (0.1–0.3 mm long). The isidia arise as hemispherical papillae, elongating into cylindrical isidia and then into lobules usually with rhizines and are unique in this genus. Among the five other species with isidia, *M. poeltii* contains fumarprotocetraric acid (PD + orange), *M. elegantula* has isidia with pseudocyphellae at the tips, *M. exasperatula* has hollow isidia, *M. infumata* has broader lobes [1–4(–6 mm)] and longer isidia (0.2–1 mm long), and *M. ushuaiensis* from southern South America has broader lobes (2–5 mm wide) and sparse isidia. In our study only one specimen of *M. subelegantula* was found. The specimen differs from typical *M. subelegantula* in the very dense cylindrical isidia, the very sparse lobules developing from isidia, and in the shorter rhizines (to 0.5 mm cf. to 1 mm long). The sparse lobules are short, small (60–110 × 40–100 μm), and occasionally rhizinate. The lobes of this specimen are 80–100 μm thick, upper cortex 8–12 μm thick, and lower cortex 8–12 μm thick.

Previously *M. subelegantula* was only known from western North America (Esslinger 1977). New to China.

Specimen examined: CHINA. **Tibet**, Gongbogyamda county, alt. 3500m, on bark, G.R. Hu h537, 24 Jul. 2004 (HMAS-L: 077825).

3. ***Melanohalea olivaceoides*** (Krog) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 883 (2004)

≡ *Parmelia olivaceoides* Krog, Norsk Polarinst. Skr. 144: 109 (1968)

≡ *Melanelia olivaceoides* (Krog) Essl., Mycotaxon 7(1): 48 (1978)

This species is characterized by the typically corticolous habit, the moderate lobes (1–4 mm broad), the lack of pseudocyphellae, isidia and pycnidia, the laminal and punctiform soralia, the granular to isidioid soredia, the rare apothecia, the black lower surface, the moderate rhizines, and the presence of fumarprotocetraric and protocetraric acids (PD + orange, K–, C–, KC–, or sometimes lacking lichen substances). *M. olivaceoides* is related to the other five species containing fumarprotocetraric, namely *M. olivacea*, *M. septentrionalis*, *M. halei*, *M. poeltii*, and *M. gomukhensis*. However, the former four species are all esorediate, and *M. gomukhensis* has distinctive pseudocyphellae. In our study only one specimen of *M. olivaceoides* was found and this specimen lacked apothecia. The lobes were 80–100 μm thick, the upper cortex 8–12 μm thick and lower cortex 8–12 μm thick.

Melanelia olivaceoides has been reported from Alaska, Canada, United States, Europe, Siberia, Japan and Russia (Esslinger 1977, Makryi 1981). New to China.

Specimen examined: CHINA. **Tibet**, Gongbogyamda county, alt. 3500m, on bark, G.R. Hu h659, 24 Jul. 2004 (HMAS-L: 071066).

4. *Melanohalea septentrionalis* (Lynge) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 883 (2004)

≡ *Parmelia olivacea* var. *septentrionalis* Lynge, Bergens Mus. Årbok 1912(10): 4 (1912).
≡ *Parmelia septentrionalis* (Lynge) Ahti, Acta Bot. Fenn. 70: 22 (1966)
≡ *Melanelia septentrionalis* (Lynge) Essl., Mycotaxon 7(1): 48 (1978)

This species is characterized by the corticolous habit, the shiny lobes (1–3 mm broad), the lack of isidia, soredia and lobules, the rare or absence of pseudocyphellae, the smooth apothecial margin, the subhymenium which is thinner than the hymenium, the acerose to slightly bifusiform conidia, the black lower surface, the moderate to dense rhizines, and the presence of fumarprotocetraric and protocetraric acid (PD+ orange, K–, C–, KC–). *M. septentrionalis* is closely related to *M. halei* and *M. olivacea*. However, *M. septentrionalis* can be separated from *M. halei* by the darker colored upper surface, the absence of papillae and lobules in the central parts of the thallus, the smaller spores (9–13 × 5.5–8.5 μm cf. 15–20 × 8–12.5 μm), the weakly bifusiform rather than cylindrical conidia, and the K– rather than K+ reaction of the medulla (yellow turning dingy orange for *M. halei*). *M. septentrionalis* differs from *M. olivacea* in its smaller thalli, the less common pseudocyphellae, the presence of numerous apothecia near the thallus periphery, and the smooth rather than crenate or tuberculate apothecial margin. In addition, *M. septentrionalis* is the only species of *Melanohalea* where the hymenium is obviously thicker than the subhymenium (2 × the thickness of the latter). In our study only one specimen of *M. septentrionalis* was found. The specimen had an obviously shiny and rugose upper surface. the lobes were 100–120 μm thick, the upper cortex 12–14 μm thick and lower cortex 10–12 μm thick. The hymenium was 70–100 μm high, and subhymenium 35–50 μm high. The spores are ellipsoid (9–11 × 6–8 μm), and spore wall 1 μm thick. Conidia are weakly bifusiform, 5–7 μm long.

M. septentrionalis has been reported from North America, Europe, Russia and India (Esslinger 1977, Öztürk 1990, Spribille & Kolb 2000, Motiejunaite 2002, Divakar & Upreti 2005). New to China.

Specimen examined: CHINA. **Heilongjiang**, Linchang, Mt. Dabaishan, alt. 1200 m, on bark, X.Q. Gao, 405, 3 Sep. 1984 (HMAS-L: 036135).

Key to *Melanelia*, *Melanelixia* and *Melanohalea* in China

1a. Thallus with soredia or isidia 2
1b. Thallus without soredia or isidia 12

2a. Thallus with isidia 3
2b. Thallus with soredia 9

3a. Medulla PD + red-orange, with fumarprotocetraric acid ...... *Melanohalea poeltii*
3b. Medulla PD –, other substances present or none 4

4a. Medulla C + rose or red 5
4b. Medulla C – 7

5a. Cortical hairs absent .... *Melanelixia fuliginosa*
5b. Cortical hairs obvious, especially on the lobe ends 6

6a. Isidia papillate, with obvious cortical hairs on the tips .... *Melanelixia villosella*
6b. Isidia cylindrical, without cortical hairs on the tips .... *Melanelixia subvillosella*

7a. Isidia mostly compressed-clavate to spathulate, hollow . *Melanohalea exasperatula*
7b. Isidia cylindrical, not hollow 8

8a. Pseudocyphellae present at the tip of isidia .... *Melanohalea elegantula*
8b. Pseudocyphellae absent; some isidia growing into lobules with rhizines .... *Melanohalea subelegantula*

9a. Medulla C + rose or red 10
9b. Medulla C –.. 11

10a. Gyrophoric acid present, cortical hairs absent .... *Melanelia tominii*
10b. Lecanoric acid present, cortical hairs present .... *Melanelixia subargentifera*

11a. Medulla P + red-orange, with fumarprotocetraric and protocetraric acid; corticolous; soralia punctiform, laminal .... *Melanohalea olivaceoides*
11b. Medulla P–, with perlatolic and stenosporic acid; saxicolous; soralia granular to isidioid, on the ends of the ascending lateral branches ...... *Melanelia sorediata*

12a. Medulla P + orange or red-orange 13
12b. Medulla P – 16

13a. Pycnidia exogenous, medulla with stictic and norstictic acids .... *Melanelia hepatizon*
13b. Pycnidia not exogenous, medulla with fumarprotocetraric and/or protocetraric acids 14

14a. Saxicolous; upper cortex thicker (30–50 μm); conidia bifusiform .... *Melanelia stygia*
14b. Corticolous; upper cortex thinner (8–14 μm); conidia acerose to weakly bifusiform 15

15a. Apothecia margin smooth; hymenium twice as thick as subhymenium .... *Melanohalea septentrionalis*
15b. Apothecia margin crenate or tuberculate; hymenium as thick as subhymenium .... *Melanohalea olivacea*

16a. Medulla C + rose or red 17
16b. Medulla C– 20

17a. Medulla with gyrophoric acid; lobes distinctively pseudocyphellate; saxicolous .... *Melanelia tominii*
17b. Medulla with lecanoric acid 18

18a. Cortical hairs present .... *Melanelixia glabra*
18b. Cortical hairs absent 19

19a. Thallus saxicolous; pseudocyphellae absent; apothecia rare .... *Melanelixia glabroides*
19b. Thallus corticolous; pseudocyphellae present; apothecia common .... *Melanelixia huei*

20a. Corticolous usually; no lichen substances detected; papillae conical, with conspicuous pseudocyphellae at the tip .... *Melanohalea exasperata*
20b. Saxicolous; perlatolic and stenosporic acid present; without papillae 21

21a. Lobules abundant, marginal to laminal; pseudocyphellae absent or faint .... *Melanelia panniformis*
21b. Lobules absent; pseudocyphellae obvious .... *Melanelia predisjuncta*

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A new *Entoloma (Basidiomycetes, Agaricales)* from Tasmania

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Abstract — A description is given of a new *Entoloma* species from *Eucalyptus* forest with *Leptospermum* understorey in Tasmania, Australia, with striking yellow lamellae. Notes are given on similar species on a worldwide basis.

Key words — *Entolomataceae*, mycorrhizal, *Myrtaceae*, new species, taxonomy

Introduction

In Tasmania, numerous species of *Entoloma* and related genera can be found, of which many are new to science. Previous papers on the family *Entolomataceae* in Tasmania were confined to the genera *Rhodocybe* (Baroni & Gates 2006) and *Entoloma* (Gates & Noordeloos 2007). Although, in general, the mycota of Tasmania has affinities with that of New Zealand, it is remarkable that only a limited number of *Entoloma* species are common to both places (Horak 2008). Whether this is due to the absence of eucalypts in New Zealand forest is well worth investigating, especially since it has been proved that *Entoloma* may be (in part) mycorrhizal (Agerer & Waller 1993, Agerer 1997, Kobayashi & Hatano 2001). Many Tasmanian species find counterparts in the flora of South-east Asia (Horak 1980, Noordeloos & Hausknecht 2007, Manimohan et al. 2006).

Materials and methods

Collections of the new species were made from two sites, one in north-eastern Tasmania and the other in south-western Tasmania. The north-eastern site,

classified as a high altitude rainforest at an elevation of 850 m is dominated by *Eucalyptus delegatensis* R.T. Baker with a *Leptospermum lanigerum* (Aiton) Sm. understorey, both of these species being from the *Myrtaceae*, which are known to form ectomycorrhizas (Smith & Read 2008). The south-western site, classified as a low altitude wet sclerophyll forest with rainforest understorey species, is dominated by *Eucalyptus obliqua* L'Hér. with a *Leptospermum scoparium* J.R. Forst. & G. Forst. and *Melaleuca squarrosa* Donn ex Sm. understorey, all in the family *Myrtaceae*.

Fresh collections were photographed and described with colour notations according to Kornerup & Wanscher (1978). Mounts for microscopic analysis were made from fresh and dried material and examined in water, 10% NH_4OH, 3% KOH, or ammoniacal Congo Red. All measurements were made in 10% NH_4OH or 3% KOH. For basidiospore measurements, the hilar appendix was excluded. The spore quotient Q refers to the length divided by the width of an individual spore. Drawings of basidiospores, cystidia and other microscopic structures were made with the aid of a drawing tube attached to a light microscope. The holotype specimen is deposited in the Tasmanian Herbarium (HO); an isotype is deposited at the National Herbarium of the Netherlands, Leiden (L). Collections cited are deposited at HO or L as designated.

Taxonomic description

Entoloma mathinnae G.M. Gates, B.M. Horton & Noordel., **sp. nov.** FIG. 1.
MYCOBANK 512019

Habitus tricholomatoideus. Pileus 40–80 mm, pallide brunneus, glaber. Lamellae distantes, crassae, luteae. Stipes 40 × 25 mm, albidus demum pallide brunneus, glaber, fibrillosus. Sporae 6.5–8 × 6–8 µm, isodiametrae. Cystidia absentia. Pileipellis (ixo-)cutis hyphis 2.0–4.0 µm latis pigmento brunneo. Fibulae abundantes. ***Holotypus****: Australia, Tasmania, Mathinna, Ben Ridge Rd, 12 Feb. 2008, G. Gates E2263 (HO548298, isotypus L).*

ETYMOLOGY: From Mathinna, a 19th Century Aboriginal girl, a victim of the early interactions of Aboriginal and European cultures, after whom the type locality district was named.

MACROCHARACTERS — PILEUS 40–80 mm broad, convex to plano-convex with low umbo, not distinctly hygrophanous, light yellow-brown (5D5), paler towards margin, smooth, glabrous or slightly viscid becoming rimose with age; LAMELLAE crowded, L = about 80, l = 3–5, adnate-emarginate, ventricose, up to 10 mm broad, bright lemon yellow (about 3A-B6), with entire, concolorous edge; STIPE 50–85 × 15–20 mm, cylindrical, tapering at base, white or pale brown, occasionally with a distinct grey-violet (16E3) hue, innately fibrillose all over, solid then fistulose; CONTEXT firm, white; SMELL AND TASTE indistinct, fungoid.

MICROCHARACTERS — BASIDIOSPORES 6.5–8 × 6–8 µm, average 7.3 × 6.9 µm, Q = 1.0–1.2, irregularly 6–8 angled with thin walls and weak angles; BASIDIA

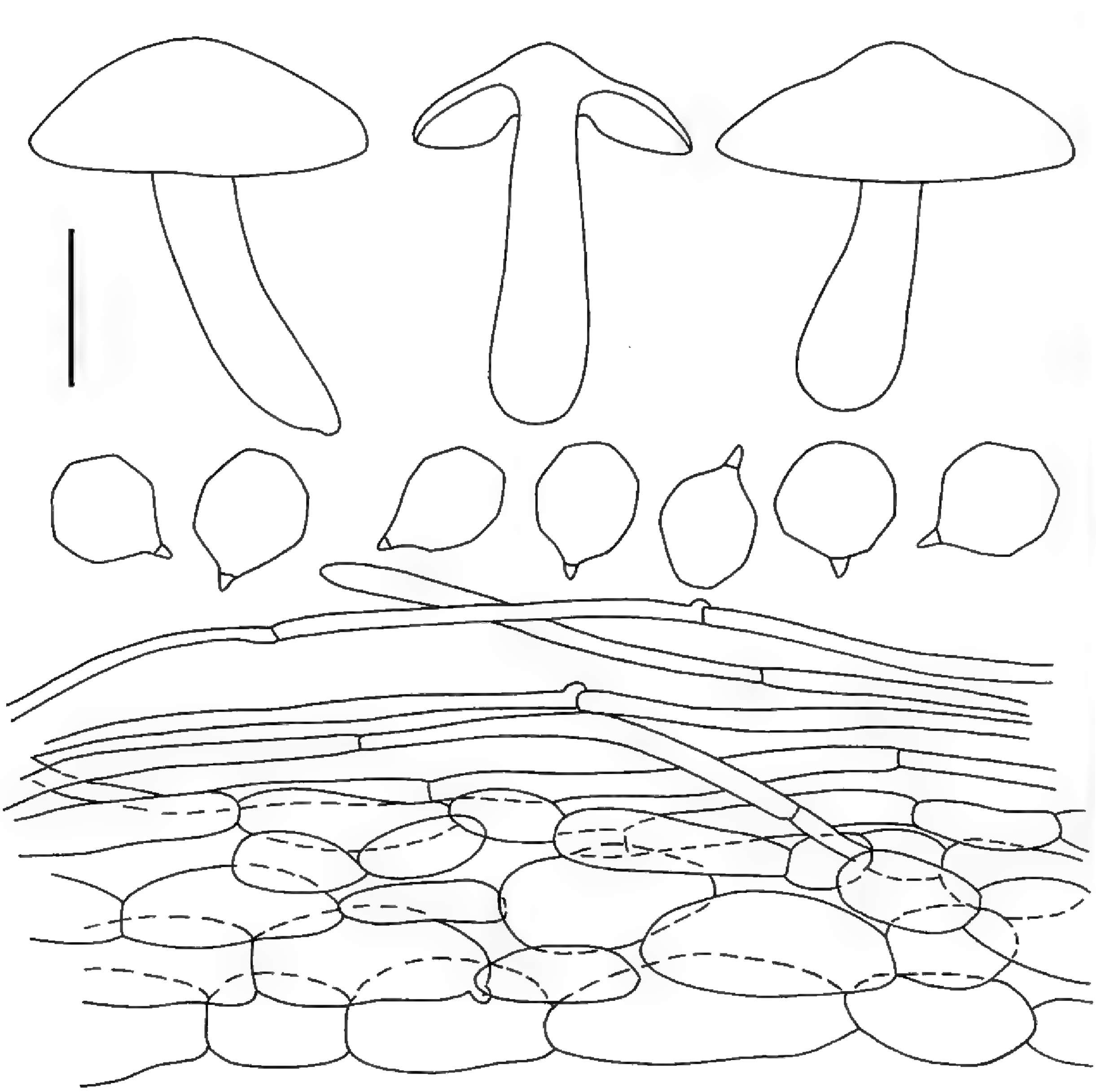

Fig. 1. *Entoloma mathinnae*. Habit, spores and pileipellis.
Bar = 10 μm (spores); 20 μm (pileipellis); and 3 cm (habit).

20–34 × 7–9 μm, 4-spored, clamped; Lamella edge fertile; Cheilo- and pleurocystidia absent; Hymenophoral trama regular, made up of short, inflated elements, 30–70 × 8–25 μm with pale yellow, intracellular pigment; Pileipellis a differentiated (ixo-)cutis; Suprapellis slightly gelatinized ixocutis of 2–4 μm wide, cylindrical hyphae; Subpellis well differentiated, made up of inflated elements, 35–80 × 8–25 μm; Pigment brown, intracellular mainly in suprapellis; Pileitrama regular, made up of inflated elements, 50–120 × 7–27 μm; Clamp connections abundant.

Ecology, range, distribution — In wet *Eucalyptus delegatensis* high altitude rainforest with *Leptospermum* understorey and in *Eucalyptus obliqua* low altitude wet sclerophyll forest with *Leptospermum* and *Melaleuca* understorey.

Representative specimens examined — AUSTRALIA. Tasmania: **Mathinna**, Ben Ridge Rd, (Lat./long. 41°21'S × 147°40'E), 12.II.2008, G.Gates E2263 (**Holotype**,

HO548298; isotype L); **same location**, 25.III.2007, B.Horton s.n. (G.Gates E2248), HO548300; **Tahune**, Two Bridges Track, (Lat./long. 43°06'S × 146°44'E), 20.V.2007, G.Gates E2267, HO548299.

Comments — *Entoloma mathinnae* belongs to *Entoloma* section *Entoloma* on account of its tricholomatoid habit, smooth pileus, and small, weakly angled spores. The bright yellow gills, without a trace of pink, are distinctive. *Entoloma manganaense* G.M. Gates & Noordel. has similar yellow gills, but differs strikingly by the darker brown pileus and blue stipe. *Entoloma cerinum* E. Horak from New Zealand also has yellowish lamellae when young, which, however, turn dark pink with age; the pileus is very dark brown, and the hyphae are clampless (Horak 2008). *Entoloma luridum* Hesler from North America has similar yellow lamellae and small spores, but differs by the almost white basidiocarps. *Entoloma sinuatum* (Pers.) P. Kumm. from Europe and North America has a quite different yellow tinge in the lamellae, and much larger, thick-walled and distinctly angled spores, which place it in *E.* section *Rhodopolia* (Noordeloos 2004). *Entoloma luteifolium* Hesler from Cuba is a small species with a squamulose pileus, typical for *E.* section *Cyanula*.

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Volvariella cubensis: a rare neotropical agaric new to South America

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Abstract — *Volvariella cubensis* (*Pluteaceae*), a relatively rare species, is reported from South America for the first time. A discussion of the occurrence of acrophysalides in *Agaricales* and their phylogenetic implications is also provided.

Key words — *Amanitaceae, Amanita, Limacella, Pluteus, Squamanita, Russula*

Introduction

Volvariella Speg., which belongs to the *Pluteaceae* Kotl. & Pouzar (*Agaricales*, *Basidiomycota*), is easily recognised by its pink spore print, presence of a saccate volva at the stipe base, and the bilateral, inverse lamella trama (Singer 1986). In addition, the presence of acrophysalides in the stipe context was reported in *Volvariella* (Reijnders 1993).

The earliest records of this genus in Brazil were given by Rick (1961, summarizing 1907, 1919, 1920, 1924, and 1938), who cited ten taxa, all from Rio Grande do Sul State. Singer (1953, 1989), Bononi et al. (1981), Grandi et al. (1984), Pegler (1997), de Meijer (2001, 2006), Sobestiansky (2005), and Menolli-Junior & Capelari (2008) reported additional species of this genus from various Brazilian States. In Northeast Brazil, Batista (1957) recorded *Volvaria oswaldoi* Bat. and *V. speciosa* (Fr.) P. Kumm. The first name was later recombined as *Volvariella oswaldoi* (Bat.) Putzke (Putzke 1994, as "*osvaldoi*"). *Volvariella cnemidophora* (Mont.) Singer was cited by Batista & Bezerra (1960) from Northeast Brazil. The last species and *Volvaria speciosa* are synonyms of *V. gloiocephala* (DC.) Boekhout & Enderle, according to Boekhout & Enderle (1986).

In this work, *Volvariella cubensis* is described and illustrated from the northeastern Brazilian State of Pernambuco. The presence or absence of acrophysalides in the tissue of some agaric genera, a neglected anatomical topic first raised by Reijnders (1993), is also discussed.

Material and methods

Fresh material was collected and the usual methodology on the study of agaric fungi was followed. For the identification of the species Shaffer (1957) and Pegler (1983, 1988) were used. Presentation of basidiospore data follows the methodology proposed by Tulloss et al. (1992) as summarized by Tulloss & Lindgren (2005), slightly modified. At the beginning of a set of spore data, the notation "[*a*/*b*/*c*]" is to be read "*a* spores were measured from *b* basidiomata taken from *c* collections." A summary of definitions of biometric variables follows:

L (W) = average length (width) of the basidiospores measured from a single basidiome;

Q = the ratio of length to width of a basidiospore or the range of such ratios for all basidiospores measured;

Q = the average of all Q values computed for all basidiospores measured from a single basidiome.

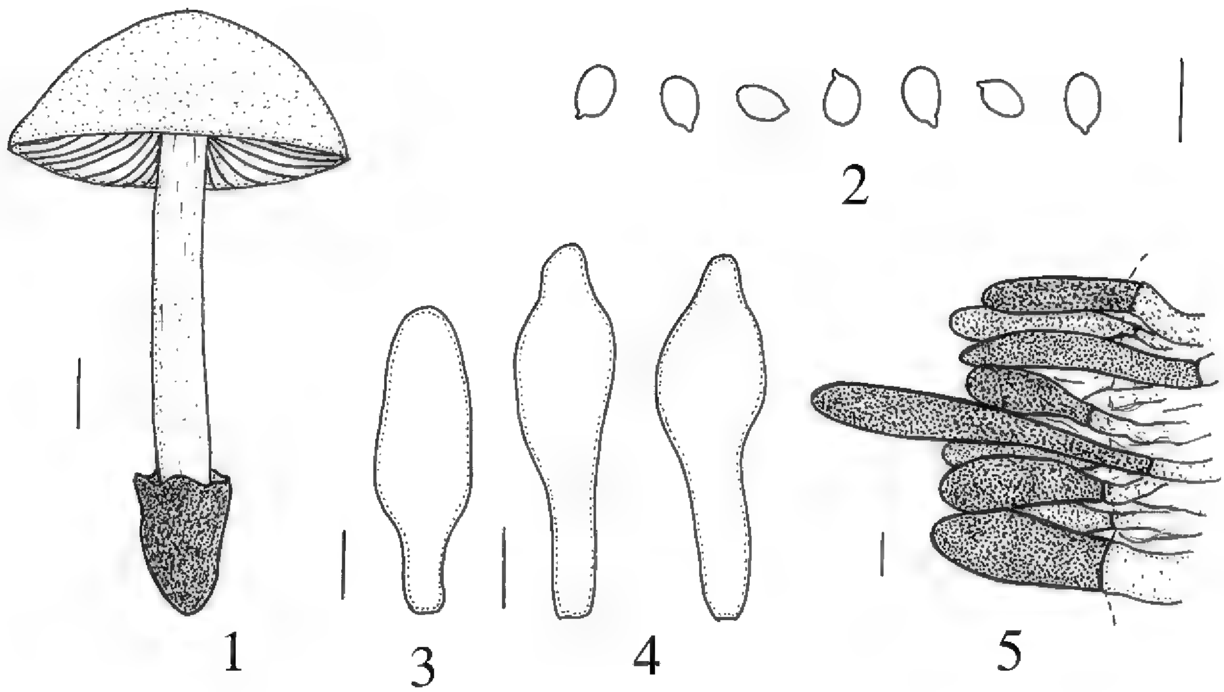
The specimen was deposited in URM (Herbarium of the Department of Mycology of the Universidade Federal de Pernambuco, Brazil).

Taxonomy

Volvariella cubensis (Murrill) Shaffer, Mycologia 49: 564. 1957. Figs. 1–5

Pileus up to 50 mm wide, campanulate then broadly convex, not fully expanding; surface grayish brown, slightly paler at margin, with minute dark fibrils, margin entire, not striate; context fleshy, up to 3 mm thick over stipe, probably white, unchanging. Lamellae free, crowded, cream at first, pinkish-brown at maturity, with lamellulae present. Stipe 68 × 9 mm, central, cylindric, solid, smooth and glabrous, cream. Volva saccate, thick, subcoriaceus, 3-lobed, grayish brown.

Basidiospores [20/1/1] 6.2–7.5(–8.4) × 4–5 μm, (L = 6.9 μm, W = 4.5 μm, Q = 1.48–1.64(–1.68), **Q** = 1.54), ellipsoid to elongate, only occasionally subovoid, smooth, with slightly thickened wall, hyaline, pinkish brown in mass. Basidia not observed, probably collapsed. Pleurocystidia difficult to observe, up to 32 × 11 μm, clavate subfusoid, thin-walled, hyaline. Cheilocystidia 28–49 × 10–15 μm, fusoid then fusoid-ventricose, thin-walled, hyaline. Pileipellis as repent trichoderm ranging up to 190 μm thick, comprising ascendant parallel non gelatinous, cylindrical hyphae up to 5 μm wide, mixed with 45–127 × 11–25 μm, cylindrical to fusoid inflated elements, having dark brown vacuolar pigment. Lamellar trama bilateral inverse. Stipe context with infrequent inflated terminal hyphal segments (e.g. 150 × 15–30 μm). Volva with 3–10 μm wide filamentous hyphae in limb and with outer surface covered by, 30–120 × 10–22 μm, clavate to cylindrical cells, brownish colored and arising from the volval tissue, slightly gelatinized. Clamp connections absent from all tissues.



Figures 1-5. *Volvariella cubensis*.
1. Habit. 2. Basidiospores. 3. Pleurocystidia. 4. Cheilocystidia. 5. Covering of volva.
Scale bar is 10 mm for basidiome and 10 µm for microstructures.

Habitat: Solitary on rotten wood in degraded part of fallen log [*Clitoria* sp. (*Papilionaceaea*)] in urban area.

Material examined: BRAZIL. Pernambuco, Recife, Universidade Federal de Pernambuco near to CCS ("Centro de Ciências da Saúde") Building, 10.vii.2003, J. Putzke & F. Wartchow s.n. (URM 78876).

Remarks: This species with a medium size basidiome is characterised by the dark greyish brown and minutely fibrillose pileus, thick volva and the size and shape of the basidiospores—6.2–8.6 × 4.3–5.3 µm, L = 7–7.6 µm, W = 4.6–4.8 µm, Q = 1.35–1.88, **Q** = 1.46–1.67, according to Shaffer (1957). It is noted that the Brazilian collection was growing on wood, whereas *Volvariella cubensis* was originally described from soil (Murrill 1911).

Volvariella bakeri (Murrill) Shaffer, with a paler pileus ranging up to 100 mm wide, basidiospores 6.9–9.3 × 4.6–6.9 µm, L = 7.9–8.2 and W = 5.1–5.7 µm, and *V. volvacea* (Bull.) Singer with 50–100 mm wide, virgate pileus; membranous volva; and basidiospores 6.9–10.4 × 4.6–7 µm, L = 8.4–9.1 µm and W = 5.4–5.8 µm, are separated from *V. cubensis* (Shaffer 1957). Pegler (1987) stated that *V. bakeri* and *V. volvacea* are very similar species, of which the first differs only in the lignicolous habit. The other dark coloured species that occurs in Brazil, *V. pusilla* var. *taylorii* (Berk.) Boekhout is easily differentiated by the small and slender basidiome and the thin, membranous volva (Pegler 1997).

Volvariella cubensis is a neotropical species originally described from Cuba (Murrill 1911, as *Volvariopsis cubensis*). Pegler (1983) cited it from Guadeloupe

reporting smaller spores 4.5–6 × 3–4 µm, **L** = 5.3 µm and **W** = 3.5 µm but indicating a thick volva for the collection that is typical of this species. The present taxon is now added to 16 taxa of *Volvariella* previously known from Brazil (Putzke & Wartchow 2008).

An interesting anatomical feature can be noted in the saccate volva of the present species. Long cystidioid bodies arise from the volval limb, which comprises plentiful filamentous hyphae. In *V. cubensis* the author observed the cystidioid bodies in the volva as being very similar to cells seen in the pileipellis. Courtecuisse (1991), on the other hand, analyzed anatomically the volval tissues of two neotropical species but found only filamentous hyphae in them. The presence of these cystidioid bodies in two tissues that are adjacent during basidiome development suggests a common (possibly hormonal) cause for their presence in the tissues.

In examining the stipe tissue of the recent Brazilian collection of *V. cubensis*, a slightly inflated cell that had a certain resemblance to an acrophysalide was noted in one section. Acrophysalides (Bas 1975) are clavate terminal cells extending from a diffuse system of usually narrow, branching hyphae in the stipe and pileus context, a tissue that is characteristic of the stipe context within *Amanita* Pers. and *Limacella* Earle (Bas 1969). In the stipe tissues of these taxa, the acrophysalides are longitudinally oriented.

Reijnders (1993) reported the presence of inflated cells in the stipe or pileus context in several agaric genera, e.g., in *Russula* Pers., *Squamanita* Imbach, *Pluteus* Fr. (*P. granulatus* Bres., see Reijnders 1993: 262, fig. 16–17) and *Volvariella*. With regard to the diversity of genera that bear acrophysalides, Reijnders (1993: 261) concluded that "the acrophysalidic trama is merely a more conspicuous expression of a feature common in the *Agaricales*." This statement deserves review based on current evidence.

Squamanita is a mycoparasitic genus (Bas 1965), and *Amanita* is one of the taxa parasitized by it (Redhead et al. 1994, Bas & Thoen 1998, Bas & Tulloss unpub. data on European and Asian collections), and there is no evidence that the acrophysalides supposedly belonging to *Squamanita* are really from *Squamanita* tissue. The "protocarpic tubers" (= cecidiocarps, according to Bas & Thoen 1998), where the acrophysalides were previously found (e.g. Singer & Clémençon 1972, as "primordial bulbs") does not belong to the *Squamanita* basidiome; they are galls provoked by infection of the basidiome of another agaric (Redhead et al. 1994) and believed to belong to the *Amanita* "host" of that parasite. Tulloss (pers. corresp.) also proposes that the hypothesis that the sphaerocysts of the *Russulales* are related in some way to the acrophysalides of *Amanita* is unproven (as also previously concluded by Reijnders 1977: 356) and does not account for the radically different ontogenies of the two fungal groups involved—*Amanita* is the only genus known to exhibit schizohymenial

development (see also Bas 1969)—or molecular phylogenetic studies of the last decade.

Recent molecular studies include *Pluteaceae* and *Amanitaceae* as possible sister taxa in a single clade, although with very weak support (Matheny et al. 2006). Although some authors may interpret this placement as somewhat justifying Reijnder's theory that *Pluteus* and *Volvariella* both have acrophysalidic stipe tissue, there is really no sound argument for deriving such a position from currently available molecular evidence. Moreover, recent anatomical analyses of stipe tissues from representatives of two neotropical *Volvariella* species have not produced evidence of inflated elements (Courtecuisse 1991). It is necessary to exercise caution before affirming the existence of acrophysalides in stipe tissue within the *Pluteaceae* s. str. Only a careful anatomical revision of a well-chosen sample of species will confirm whether or not true acrophysalides exist in *Pluteus* and *Volvariella*.

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Lichenostigma epirupestre, a new lichenicolous species on *Pertusaria* from Spain

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Abstract—The new species *Lichenostigma epirupestre* is described from three localities in Central Spain, growing on *Pertusaria pertusa* var. *rupestris*. Remarks on its taxonomy and closely related species are made and a key to the species of *Lichenostigma* subgenus *Lichenostigma* is also included.

Key words—Iberian Peninsula, lichenicolous fungi, lichens

Introduction

The genus *Lichenostigma* was introduced for *L. maureri* Hafellner (Hafellner 1982) and, since then, a total of 21 species (after www.indexfungorum.org) have been referred to it. Two subgenera are recognized: *Lichenostigma* and *Lichenogramma* (Navarro-Rosinés & Hafellner 1996, Calatayud et al. 2002). Species belonging to subgenus *Lichenostigma* are characterized by having cushion-like ascomata and by the absence of visible vegetative hyphae or strands connecting several ascomata on the surface of the thallus. Taxa included in subgenus *Lichenogramma* show rounded or elongate ascomata that are interconnected by brown hyphae or pluricellular strands. While most species can easily be referred to one of these two subgenera, a few species show some intermediate features. This is the case of species in which the rounded shape of the ascomata is typical of subgenus *Lichenostigma*, but developing immersed (not visible on the host thallus) brown vegetative hyphae, or others that only occasionally develop superficial hyphal strands but only occasionally (Calatayud & Barreno 2003, Halıcı & Hawksworth 2007). The study of some *Lichenostigma* species is difficult due to their small size, morphological variability, high frequency of sterile material and, in some taxa, their diffuse

limits with regard to the species included in the close genus *Lichenothelia* (Calatayud et al. 2002). Recently, the concept of *Lichenostigma* has been enlarged to include also a species with macroconidia (Ihlen 2004), a feature so far considered characteristic of *Lichenothelia* (Henssen 1987). It is expected that molecular studies will contribute to provide relevant information to allow a better delimitation of *Lichenostigma*, and to clarify the relationships among species as well as increase our knowledge of the possible subgroup entities.

During the study of the lichen flora of Tiermes, this being a 3500 years old settlement in the province of Soria (Spain) including a celt-iberic city carved in sandstone, a new species of *Lichenostigma* was collected growing on *Pertusaria pertusa* var. *rupestris*. Further material was later examined from two other localities in central Spain. In the present paper, this new species is described and compared with other related taxa. An artificial key for species of the *Lichenostigma* subgenus *Lichenostigma* is also provided.

Material and methods

Microscopic characters were studied in hand sections mounted in water, 10% KOH (K), Lugol's iodine solution or lactophenol cotton blue, using a Zeiss Axioskop and a Nikon E200 light microscope. All measurements were made in water. For the ascospore size, the range was calculated after manually rejecting 10% of the highest and 10% of the lowest measured values; extreme values are given within parentheses, and the average in italics. Pictures were taken with a Canon PowerShot G2 digital camera fitted to the microscope. Abbreviations: K = 10–35% potassium hydroxide in water; I = Lugol's iodine solution; K/I = pretreatment with K followed by I.

Lichenostigma epirupestre Pérez-Ortega & Calat., **sp. nov.**

MycoBank MB 512489

Fungus lichenicola in Pertusaria pertusa *var.* rupestris *crescens. Hyphae vegetativae immersae brunneae. Asci in ascomatibus immersi, 20–24 × 10–14 μm. Hamathecii filamenta absentia. Ascosporae 2(–3)-cellulares, brunnescentes, 11–14 × 6.6–8 μm.*

Etymology: Named in reference to the host species.

Holotype: Spain. Soria: Montejo de Tiermes, old celtiberic settlement of Tiermes, 41°19'49" N, 3°8'59" W, 1170 m, on *Pertusaria pertusa* var. *rupestris* on sandstone, 11 March 2007, Pérez-Ortega (MAF- 15586 HOLOTYPUS).

Morphology. Ascomata superficial on the host (Figs A & B) not connected to other ascomata with pigmented vegetative hyphae (subgenus *Lichenostigma*); ascomata cushion-like, black, irregularly rounded, branched or of a radiating shape (Fig. B), 80–270 μm in diam. (reaching c. 900 μm when several ascomata converge), 40–95(–110) μm thick, flat to slightly convex in central parts, where the asci are produced; lower part of the ascomata sometimes with pale brown

pigmented vegetative hyphae penetrating downwards in the host thallus, mostly simple, very rarely branched, up to c. 65 µm long, cells rounded to elongate, 5–7 × 4.5–6 µm, with a granulose extracellular pigment (Fig. F); branches of 35–70 × 22–40 µm; ascomata not producing any visible damage to the host thallus. Ascomata in section pseudoparenchymatous (Figs C & E), with irregularly rounded cells (3.5–)4–8(–9) µm in diam., external cells brown, internal cells hyaline to light brown. Hamathecial filaments absent. Asci immersed in cavities in the ascomata, bitunicate, broadly saccate, 20–24 × 10–14 µm, fragile, non-amyloid but with a K/I+ blue sheath, amyloid ring not observed, 4–6-spored (Fig. D). Intercellular spaces with a I+ blue, K/I+ blue gel. Ascospores (Figs G–J) brown, ellipsoid to broadly ellipsoid, verrucose when young (Fig. G), very old ascospores with cracked-like surface (Fig. J); 1–2(–3)-septate, very old ones rarely with transverse septa (submuriform), 11–*12.6*–14(–15) × (6–)6.6–*7.1* –8(–9) µm (*n*= 33); lower cell smaller than upper cell, clearly seen in young spores. Anamorph not seen.

Ecology and distribution. To our knowledge, *L. epirupestre* is a lichenicolous fungus growing exclusively on *Pertusaria pertusa* var. *rupestris*, a saxicolous lichen growing on acidic rocks. It has a mainly superficial growth on the host thallus, not causing any apparent injury to the host. So far, the species is known from three localities in central Spain.

Other specimens examined: ***Lichenostigma epirupestre***: **SPAIN**. Castilla y León, Ávila, La Hija de Dios, berrocal, 40° 31.346’ N, 4° 58.071’ W, 1230 m, 4 Oct 2007, Pérez-Ortega & L.G. Sancho, (Herb. Pérez-Ortega); Madrid, La Cabrera, Sierra de la Cabrera, pico de El Mojón, 30TVL4623, 1240 m, 27 Oct 1985, V.J. Rico 374/4 & M.A. Florido (Herb. Rico). ***Lichenostigma*** sp.1: Castilla-La Mancha, Cuenca, Pico Ranera, 30SXK4408, 1400 m, 18 July 1992, on *Pertusaria* cf. *leucosora*, V. Catalatyud (VAL-Lich). ***Lichenostigma*** sp. 2: Andalucia, Almería, Cabo de Gata, San josé, Playa de monsul, 30SWF7565, 15 m, 16 Sept 2000, V. Calatayud & C. Trescolí (VAL-Lich). ***Lichenostigma rugosum***: Burgos, Fresnillo de las Dueñas, N 41° 38’; W 3° 37’, 790 m, on terricolous *Diploschistes diacapsis*, 23 May 2006, Pérez.Ortega (Herb. Pérez-Ortega).

Remarks

Before the inclusion of *L. epirupestre*, 7 species had been referred to *Lichenostigma* subgenus *Lichenostigma* (Calatayud et al. 2004). *L. epirupestre* is the only one to date reported on *Pertusaria*. It was found exclusively on *Pertusaria pertusa* var. *rupestris*, a saxicolous lichen on siliceous rocks. In the course of our studies, we also examined two apparently undescribed *Lichenostigma* species growing on saxicolous *Pertusaria* species. Unfortunately, the material was scarce and always sterile, preventing a formal description. *Lichenostigma* sp. 1, was found growing on *Pertusaria* cf. *leucosora* in Cuenca (central Spain). It forms dense networks of radiating and much branched pluricellular strands over the host thallus up to 1 mm in diam (subgenus *Lichenogramma*). Hyphal strands are

10–35 µm thick, composed of up to 8 cells rows (cells 3–6 µm in diam). Only one ascoma has been observed, ± 60 µm in diam, paraplectenchymatic in section, with cells up to 7 µm in diam. The second taxon, *Lichenostigma* sp. 2, was found on an unidentified sorediate *Pertusaria* growing on volcanic rocks (S Spain). It forms a dense network of pluricellular strands (sections up to 25 µm in diam), with cells 3–5 µm in diam. *Lichenostigma* sp. 2 is apparently very close to *Lichenostigma* sp. 1, which resembles under the dissecting microscope. As *Lichenostigma* sp. 1 forms more widespread networks (up to 1 mm in diam) than *Lichenostigma* sp. 2 (up to 0.5 mm) we are sure if they are distinct or not. Both specimens are clearly separated from *L. epirupestre* by their hyphal strand network growing on the host thallus, typical for the subgenus *Lichenogramma*.

In addition to host specificity, *L. epirupestre* is characterized among species of subgenus *Lichenostigma* by the following combination of characters: ascomata mostly irregular in shape (from rounded to ± radiating), relatively small, scattered to confluent, with its lower part sometimes provided with pale brown vegetative hyphae which penetrate downwards the host thallus, and 1 or 2-septate brown ascospores. Similar brown vegetative hyphae arising from the lower side of ascomata are also known in *L. radicans* Calat. & Barreno (Calatayud & Barreno 2003), a lichenicolous fungus described on vagrant *Aspicilia* species. In this species however, the ascomata are rounded and mostly scattered, and the brown vegetative hyphae are longer (up to 180 µm) than in *L. epirupestre* (up to 70 µm), and may be ramified; in *L. epirupestre* they are simple, short and perpendicular to the lower ascomatal surface. *L. canariense* Etayo & Van den Boom, recently described on *Aspicilia calcarea*, differs mainly by its much smaller ellipsoidal or subglobose ascomata, 25–90 µm in diam., and smaller, smooth ascospores, 8.5–10.5 × 5–6 µm (Boom & Etayo 2006). *L. maureri* has more regularly rounded ascomata, which are smaller (70–120 µm in diam.), has a centrum not reacting with I, and the ascospores are slightly smaller (912 36 µm), with only one septum (Hafellner 1982); it grows on diverse fruticose and foliose lichens. *L. rugosum* G. Thor mainly differs from *L. epirupestre* by its ± rounded ascomata, the absence of brown vegetative hyphae, and distinctly halonate ascospores (Thor 1985); in both species, the old ascospores may show superficial fissures and may have more than one septum. The recently described *L. dimelaenae* Calat. & Hafellner (Calatayud et al. 2004) differs from all these species by often laterally compressed ascomata forming dense groups that are

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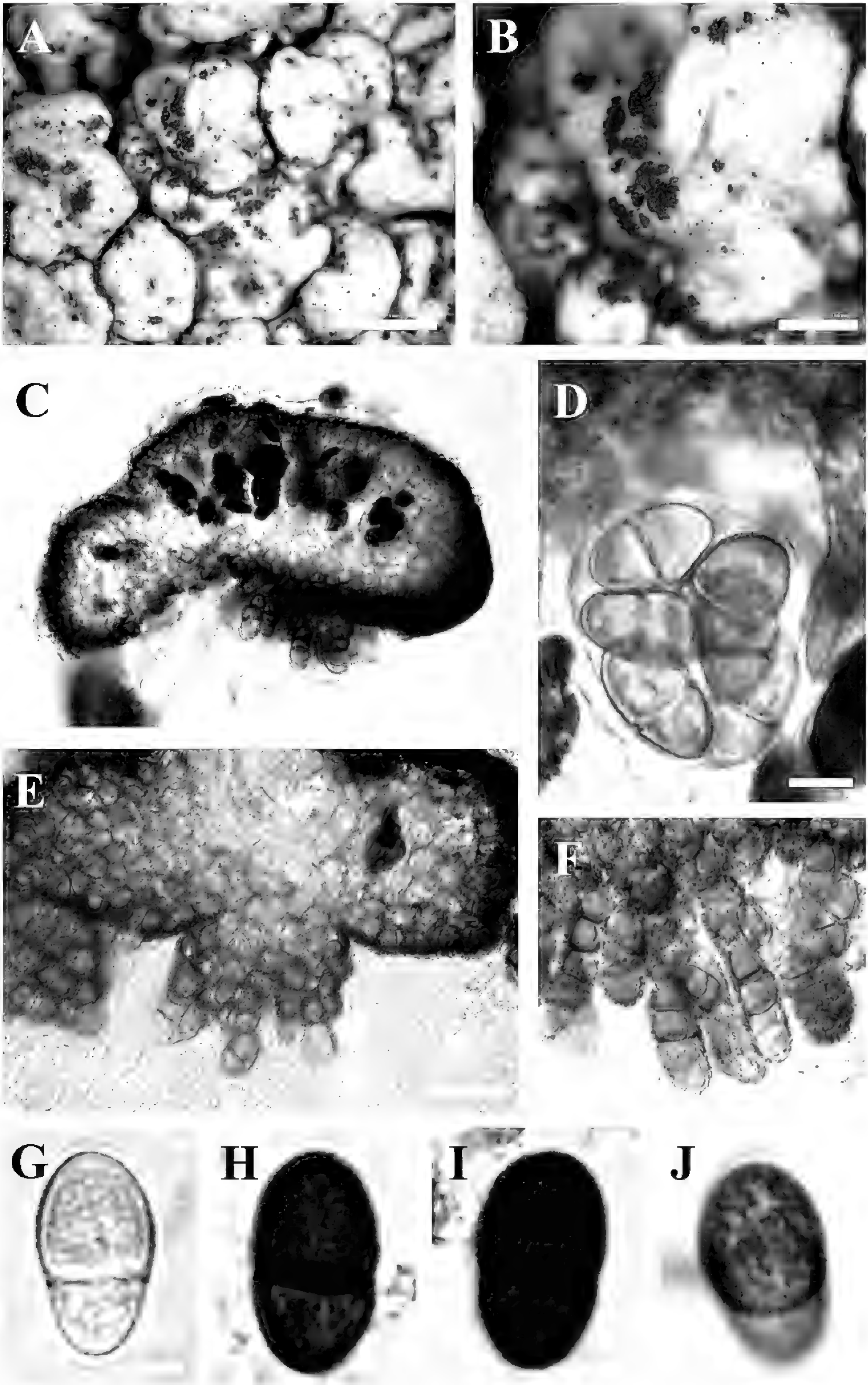
Fig. 1. A & B: Habitus; C: Transverse section of an ascomata; D: Ascus containing 8 ascospores; E: Lower part of an ascoma showing hyphae penetrating in the host thallus; F: Detail of penetrating hyphae in host thallus; G: Young ascospore with granulose surface; H: Mature ascospore; I: Old ascospore showing oblique septa in the lower cell; J: Old ascospore with cracked surface. All microscopical photographs in water, except D in KOH.G, H, I & J made with differential interference contrast.

Scale bars: A: 1 mm; B: 0.5 mm; C: 50 µm; D: 5 µm; E & F: 25 µm; G, H, I, J: 2.5 µm.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inserted laterally on the areoles of the host *Dimelaena oreina*. Other species of the subgenus can be more easily separated from *L. epirupestre* by distinctive characters. *L. hyalosporum* Kalb & Hafellner is the only species with hyaline ascospores, it grows on *Haematomma* (Kalb et al. 1995). *L. triseptatum* Halıcı & D. Hawksw. has been recently described on *Aspicilia*, and its predominantly 3-septate ascospores are considered a diagnostic feature against the other species of this subgenus (Halıcı & Hawksworth 2007). Finally, *L. lecanorae* Calat. & Nav-Ros. grows on *Lecanora farinacea* and has larger ascomata, 100–300 µm wide (Calatayud et al. 2004).

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We are very grateful to Dr. P. Diederich and Dr. V. Atienza for their valuable comments and reviewing this paper. SPO is very obliged to the project ANT-COMPLEX (CGL2006-12179-CO2-01, MEC, Spain) for support. The CEAM Foundation is partly supported by Generalitat Valenciana, Bancaja, and the Program CONSOLIDER-INGENIO 2010 (GRACCIE). Finally, we are obliged to V.J. Rico and the herbarium VAL-Lich for the loan of specimens.

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Key to the species of *Lichenostigma* subgen. *Lichenostigma*[1]

1 Ascospores predominantly 3-septate, 12–16.5 × 6.5–10 µm; on *Aspicilia* .... ***L. triseptatum***

Ascospores mostly 1(–2)-septate 2

2 Ascospores hyaline; on *Haematomma* .... ***L. hyalosporum***

Ascospores brown, not on *Haematomma* 3

3 Ascomata 100–300 µm wide and 120–200 µm tall, shape usually irregular; ascospores 10–15 × 6–9 µm; on *Lecanora farinacea* .... ***L. lecanorae***

Ascomata smaller and shorter; not on *Lecanora* 4

4 Ascomata confluent in dense compact groups, frequently compressed among them and laterally inserted on the host areoles, ascomata 70–140 µm wide and 40–80 µm tall; ascospores 1(–3)-septate, brown, 11–15 × 6.5–11 µm; on *Dimelaena oreina* .... ***L. dimelaenae***

Ascomata scattered or aggregated but not forming dense groups of compressed ascomata 5

5 Lower part of ascomata frequently producing brown vegetative hyphae that penetrate downwards the host thallus 6

Lower part of ascomata not producing vegetative hyphae or, if present, hyaline and rather indistinct 7

6 Ascomata mostly rounded, flat and scattered; brown vegetative hyphae simple to plurihyphal, up to 180 µm long; wall of inner ascomatal cells brown; ascospores 9–14 × 5–7.5 µm; on vagrant *Aspicilia* .... ***L. radicans***

Ascomata irregularly rounded to ± radiating in shape, scattered to confluent; brown vegetative hyphae short and simple, perpendicular to the lower ascomatal surface, up to 60 µm long; wall of inner ascomatal cells usually hyaline; ascospores 11–15 × 6–9 µm; on *Pertusaria pertusa var. rupestris* .... ***L. epirupestre***

7 Ascomata small, 25–90 µm diam, with its basal part composed of a layer of elongated dark brown cells in 1–4 rows; ascospores 8.5–10.5 × 5–6 µm, not ornamented; on *Aspicilia calcarea* .... ***L. canariense***

Ascomata larger, without elongate basal cells; ascospores larger and ornamented 8

8 Ascomata scattered, 70–120 µm diam; mature ascospores finely ornamented, 9–12 × 3–6 µm; on fruticose epiphytic lichens, especially *Usnea* ..... ***L. maureri***

Ascomata scattered or aggregated, 50–200 µm diam; mature ascospores with deep irregular fissures forming a rough areolate pattern, 10–13 × 5–7 µm; on *Diploschistes* spp. .... ***L. rugosum***

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[1]*Lichenostigma supertegentis* (Ihlen 2004) is not included, as its elongated ascomata and the formation of macroconidia are not typical of the subgenus.

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A new species, *Thalloloma microsporum* (*Graphidaceae, Ostropales, Ascomycota*)

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Abstract — A new corticolous species of *Thalloloma* from the Qinling Mountains in Shaanxi Province of China is described. The fungus is characterized by the small ascospores and cinnabarine lips.

Key words — lichen, morphology, taxonomy

Introduction

During a study of the lichen family *Graphidaceae* (*Ostropales*, *Ascomycota*) from Shaanxi Province, China, a corticolous species of *Thalloloma* was found in dry deciduous forests of the Qinling Mountains. It is new to science and described as *Thalloloma microsporum*. The genus as delimited by Staiger (2002) has not been reported from China before.

Material and methods

A dissecting microscope (TECH XTS-20) and a light microscope (OLYMPUS CHB-213) were used for the morphological and anatomical studies. Measurements and illustrations were taken from the manual cross-sections of fruitbodies in tap water. The lichen substance was detected and identified by thin-layer chromatography (TLC) (Culberson & Kristensson 1970, Culberson 1972).

Taxonomy

Thalloloma microsporum Z.F. Jia & J.C. Wei, **sp. nov.** Figure 1

MycoBank MB 512502

Species nova similis T. hypolepto, *a quo labellis fere cinnabarinis et ascosporis minoribus.*

Holotype: CHINA. Shaanxi Province, Qinling mountains, Banqiaogou, 33°88′N, 108°01′E, alt. 1520 m, on cortices of cortice *Zelkova serrata* (Thunb.) Makino. 29-

* Corresponding author

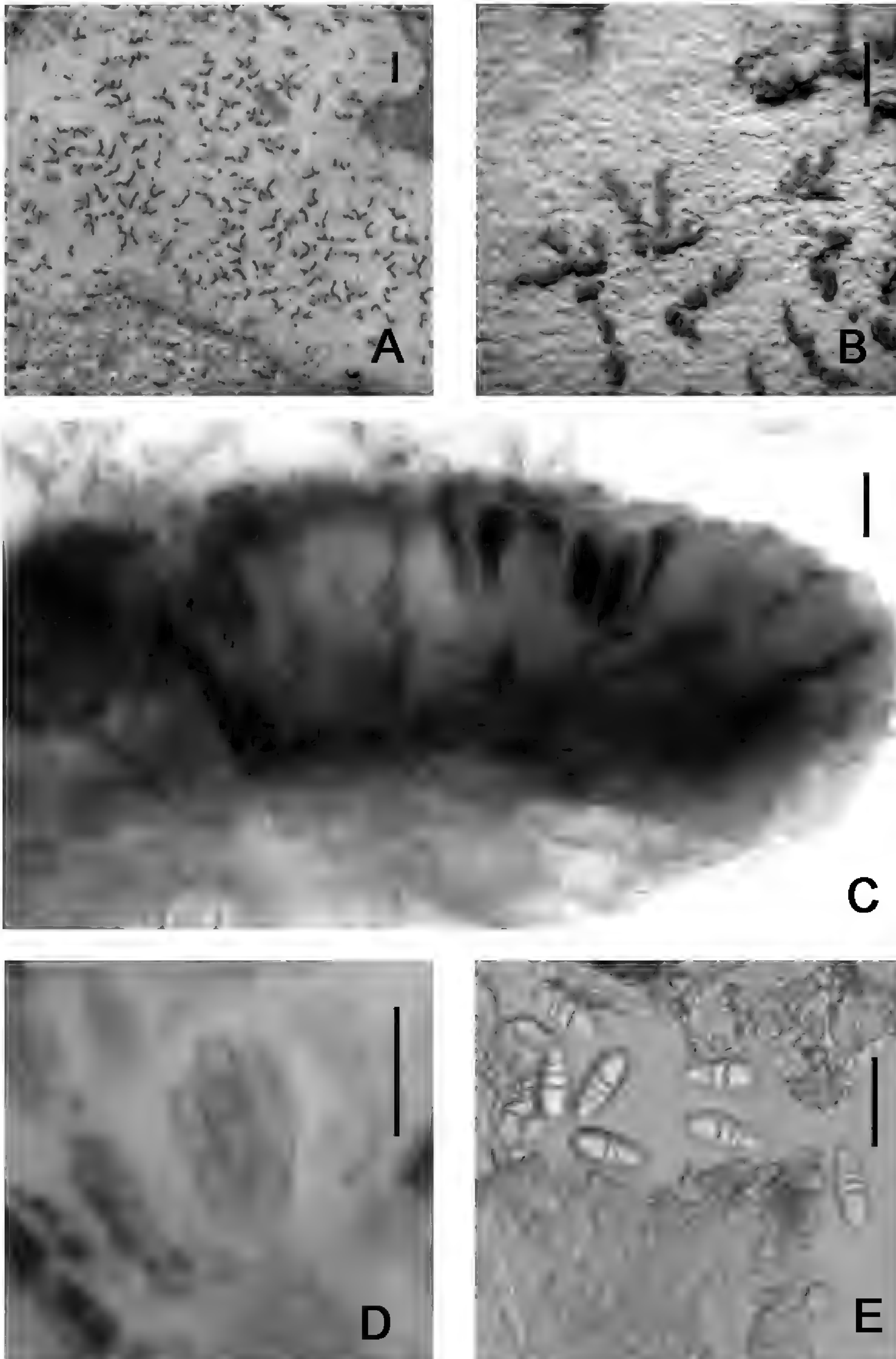

FIG. 1 *Thalloloma microsporum*. A, B. Thallus with apothecia; C. Apothecium cross section; D. An ascus containing ascospores; E. Ascospores.
Bars: A = 2 mm; B = 1 mm; C, D & E = 20 µm.

VII-2005, Ze-feng Jia SQ380 (holotype in LHS; isotype in HMAS-L.); paratypes: ibid., on cortices of *Pinus armandii* Franch. 29-VII-2005, Jia Ze-feng SQ374, SQ375 (LHS, HMAS-L).

ETYMOLOGY: The specific epithet "*microsporum*" refers to the small ascospores; *micro* is from Greek, small; *spora* in Greek, a seed.

Description: THALLUS corticolous, pale white to grayish-white, thin, 0.1–0.2 mm thick, with a dull surface. APOTHECIA elongate, rarely branched, apparently brown, conspicuous, sub-immersed to sessile, curved and sinuous, often with opening cinnabarine lips because of the reddish brown pigment isohypocrellin (Fig. 1A,B), 0.5–1.5 mm long, 0.1–0.25 mm wide, not grooved, without a distinguishable margin, surface of discs slightly granulous, grayish; PROPER EXCIPLE inconspicuous, not carbonized; EPITHECIUM 13–22 µm thick, brownish; HYPOTHECIUM red-brown, 15–30 µm tall; HYMENIUM slightly brown, clear, 66–80 µm tall, I+ slightly blue; PARAPHYSES with gelatinized wall, up to 1.5 µm wide, septate, enlarged at apices; ASCI club-shaped, 33–42 × 13–20 µm, 8-spored; ASCOSPORES ellipsoid with one end narrower and slightly pointed, 3-septate, hyaline, 15.5–20 × 5.5–8.0 µm, I+ blue, the largest upper cells 5.5–6.5 × 5.0–6.0 µm, the lower end cells 3.5–4.0 × 2.5–3.5 µm, the two middle rectangular cells 4.5–5.5 × 1.5–3 µm (Fig. 1E).

CHEMISTRY: C–, K–, P–; contains isohypocrellin (reddish brown pigment).

The new species is characterized by the opening with reddish lirellae, due to the presence of isohypocrellin, and small, 3-septate, hyaline ascospores. It is similar to *Thalloloma hypoleptum* (Nyl.) Staiger, but differs in the red brown to nearly cinnabarine lips and smaller ascospores (15.5–20 × 5.5–8.0 µm vs. 20–30 × 6.0–8.0 µm) (Staiger 2002). It also resembles *T. cinnabarinum* (Fée) Staiger and *T. rhodastrum* (Redinger) Staiger in containing isohypocrellin (Staiger 2002) but differs by having 3-septate ascospores.

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Craterellus excelsus sp. nov. from Guyana

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Abstract — *Craterellus excelsus* (*Cantharellaceae, Cantharellales, Basidiomycota*) is described from the Pakaraima Mountains of Guyana, where it occurs in rain forests dominated by ectomycorrhizal *Dicymbe* spp. (*Caesalpiniaceae*). *Craterellus excelsus* is noteworthy for its tall (up to 150 mm), persistent, abundant basidiomata that develop in large caespitose clusters. Macromorphological, micromorphological, and habitat data are provided for the new species.

Keywords — monodominant forest, tropical fungi, taxonomy, Guiana Shield

Introduction

In the primary rain forests of Guyana's Pakaraima Mountains, species of *Craterellus* and *Cantharellus* (*Cantharellaceae*, *Cantharellales*, *Basidiomycota*) are conspicuous components of the macromycota associated with ectomycorrhizal (EM) canopy trees of the genus *Dicymbe* (*Caesalpiniaceae*, tribe *Amherstieae*) (Henkel et al. 2002, 2004). Taxa from the *Cantharellales* occurring in these forests include *Cantharellus guyanensis*, *C. atratus*, *C. pleurotoides*, three undescribed species of *Craterellus*, and >15 *Clavulina* species, a number of which remain undescribed (Thacker & Henkel 2004, Henkel et al. 2005, 2006). Here we describe *Craterellus excelsus* as a distinct new species based on its grey-brown, persistent basidiomata that are regularly >100 mm tall and occur in large caespitose clusters, and its long basidia of variable lengths (75–101 µm) with varying numbers of sterigmata (2–6).

Materials and methods

Collections were made during the May–July rainy seasons of 2000–2004 from the Upper Potaro River Basin, within a 5 km radius of a permanent base camp

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at 5° 18' 04.8" N; 59° 54' 40.4" W; elevation 710 m. This collecting site is located in an undulating valley approximately 20 km east of Mt. Ayanganna (2200 m), and is densely forested with a mosaic of primary *Dicymbe*-dominated and mixed forests of the *Eschweilera-Licania* association (Henkel 2003). An additional collection was made from the Upper Ireng River Basin, ~30 km south of the Potaro site, in May 1998. All collections were made in forests dominated by *Dicymbe corymbosa*. Macromorphological features were described fresh in the field. Colors were described subjectively and coded according to Kornerup & Wanscher (1978), with color plates noted in parentheses. Abbreviations used in the species description indicate page number, the column, and the row; for example 8D-F5-6 indicates page 8, columns D to F, and from rows 5 to 6. Macrochemical tests were performed according to the methods of Singer (1986). Fungi were field-dried with silica gel.

Micromorphological features of fresh specimens were examined in the field with a battery-powered EPOI microscope with light optics, and those of dried specimens were examined in the laboratory with an Olympus BX51 microscope with bright field and phase contrast optics. At least 20 individual structures were measured for basidiospores, basidia, and tramal hyphae (for basidiospores, mean Q = the mean of basidiospore length/width ± standard deviation). Rehydrated fungal tissue was mounted in H_2O, 3% KOH, and Melzer's solution. Terminology for hyphal tissue construction follows that of Corner (1966). Line drawings were made from digital photographs. Specimens were deposited in the following herbaria: BRG – University of Guyana; HSU – Humboldt State University; and LSU – Louisiana State University (Holmgren et al. 1990).

Taxonomic description

Craterellus excelsus T.W. Henkel & Aime, **sp. nov.** Figs 1–2

Mycobank mb 510899

Habitus carpophori infundibuliformis fasciculato-caespitosus. Basidiomata fusca (5C4-5C5-5D4), 60–135(–150) × 7–17 mm, sterili basi incana. Basidiosporae (7)9–12 × 6.5–9 µm, subglobosae, laeves. Basidia (65–)75–101 µm longa, 2–6 sterigmatibus. Cystidia nulla. Fibulae nullae. Craterellus orinocensis similis C. excelsi basidiomae forma et basidiosporae magnitudine, sed colore fuliginoso, hymenio rugoso-striato, et basidio breviore, semper 6-sterigmatibus differt.

Holotype: *Henkel 8235* (BRG; Isotypes: HSU, NY)

Etymology. *Excelsus*, Latin, "lofty, high", referring to the tall basidiomata.

Key characters — *Craterellus excelsus* is easily recognized in the field by its large, persistent, infundibuliform grey-brown basidiomata in caespitose clusters forming abundantly during the rainy season under *D. corymbosa*. The species is distinguished microscopically by its basidia, which are long and variable in length (75–101 µm) and have varying numbers of sterigmata (2–6).

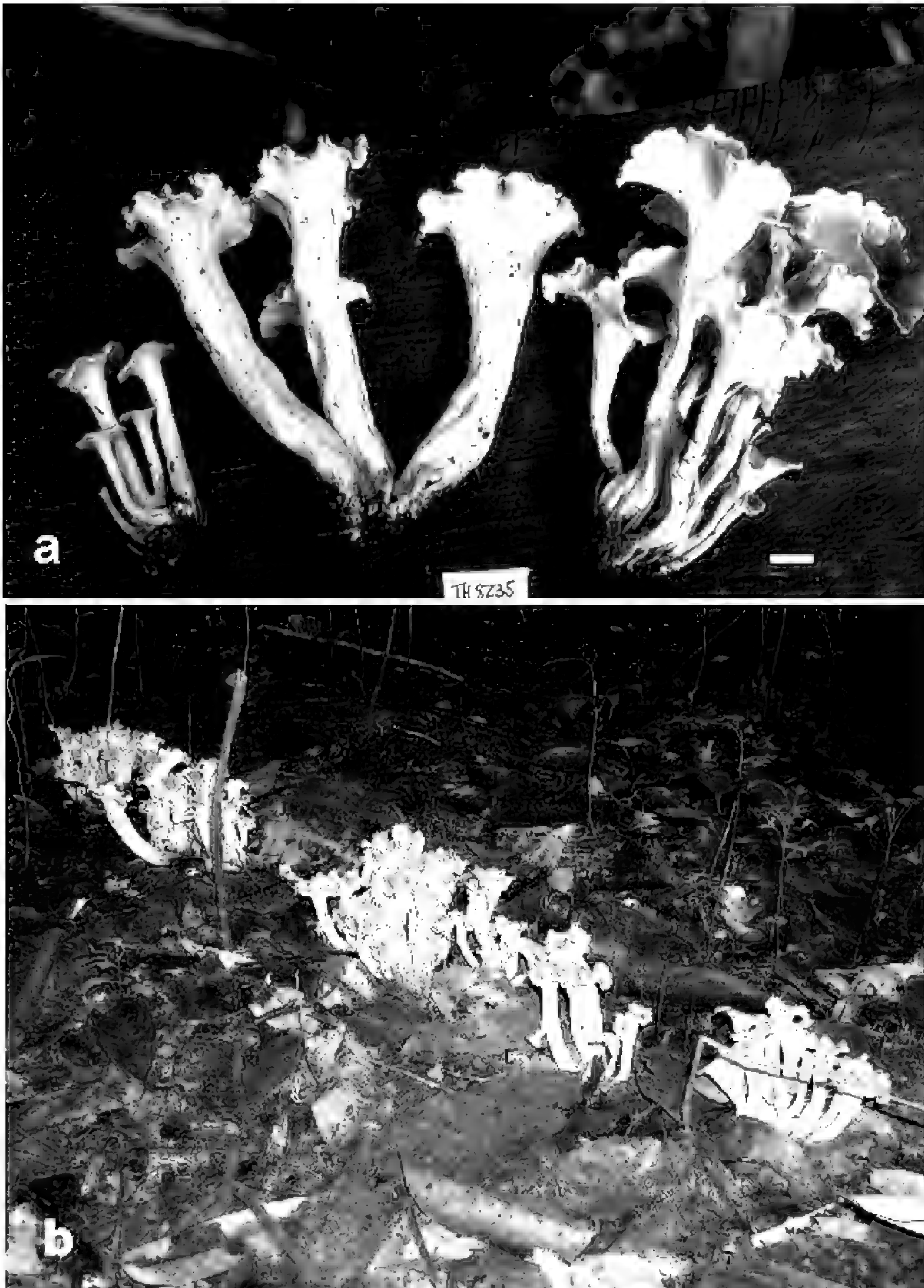

FIG. 1. Basidiomata of *Craterellus excelsus*. a. BRG HOLOTYPE Henkel 8235. Bar = 10 mm. b. Fruiting habit, Upper Potaro Basin, Guyana.

Craterellus excelsus is likely ectomycorrhizal as it has been collected only in stands dominated by EM *D. corymbosa*.

Macrocharacters — basidiomata in caespitose clusters 75–150 × 32–95(–130) mm. Individual mature basidiomata 60–135(–150) mm × 7–17 mm centrally, attenuating slightly at extreme base; apex 25–70 mm broad; smallest primordia filiform acuminate, expanding first to elongate-infundibuliform, entirely perforate, expanding further to broadly infundibuliform at maturity; inner surface light grey-brown (5C4-5C5-5D4) throughout, glabrous, hispid under hand lens; outer surface broadly and irregularly rugose, especially near base; moist; subcoriaceous; margin straight in the primordial stage, slightly outcurved during early expansion, at maturity expanding further to form larger, broadly wavy lobes, these splitting lengthwise with increased age; hymenium developing and thickening over entire outer surface though irregularly over lower half with extreme base sterile, glabrous, minutely hispid under lens, light cream grey (5B2) when young, concolorous to light grey (4B1-4B2) with age, drying tan-orange (5A4-5A5); context thin, firm and pliant; odor fragrant and fruity; taste sharp, tangy; spore deposit not obtained; edibility: edible and choice when cooked.

Microcharacters — basidiospores (7–)9–12 × 6.5–9 µm (mean Q = 1.4 ± 0.2, range = 1.1–1.8, n = 25), subglobose, smooth, inamyloid; wall hyaline; contents uniguttulate, minutely and evenly granulose, pale golden in H_20 and KOH; hilar appendix 0.6–1.2 µm long. basidia (65–)75–101 µm long, width at apex 7.4–9.3(–9.9) µm, at middle 6.8–9.3(–9.8) µm, at base (4.3–)4.9–6.8(–7.4) µm, subcylindric, tapering toward base over lower half; pre-partal basidia with opaque, minutely granulose contents, pale golden in H_20 and KOH, post-partal basidia devoid of contents and hyaline; sterigmata 4.9–8(–8.6) × 1.8–3.1 µm wide at base, cornute, (2–)3–4(–5,6) per basidium; basidioles numerous, from branched clusters, intermixed with mature basidia, pale golden in H_20 and KOH; hymenium 64–94(–124) µm thick; cystidia none; subhymenium undifferentiated; tramal hyphae branching frequently, hyaline in KOH, mostly isodiametric, some inflated; cells (69–)80–160 × (4.9–)6.8–9.9(–11.7) µm, slightly constricted at septa, lacking secondary septations; wall 0.6–1.2 µm wide; clamp connections none; medulla 900–1100 µm thick, composed of longitudinal but sinuous and tightly interwoven tramal hyphae; sterile cortex of inner surface 70–142 µm thick, scarcely differentiated from medulla, of loosely interwoven, irregularly anticlinal tramal hyphae; hyphae of sterile base undifferentiated from apical trama; secondary septations none.

Macrochemical reactions — KOH and NH_4OH nil on inner surface and hymenium.

Ecology, range, distribution — Scattered and frequent in caespitose clusters on soil and humus under *Dicymbe corymbosa* on various soil types. Fruiting prolifically during the May–July rainy season; basidiomata developing

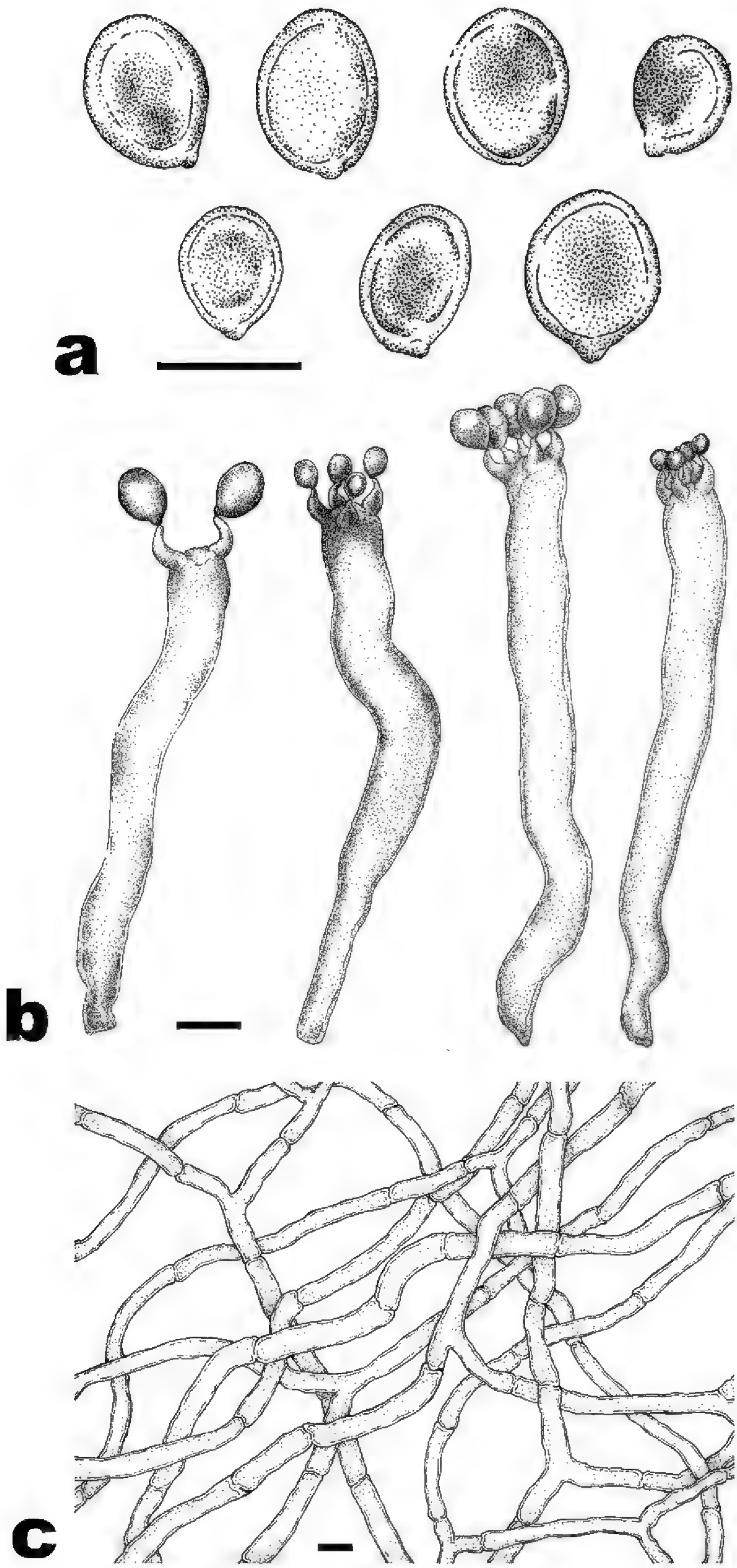

Fig. 2. Microscopic features of *Craterellus excelsus* (BRG HOLOTYPE Henkel 8235).
a. Basidiospores. b. Basidia with immature basidiospores. c. Tramal hyphae.
Bars = 10 µm.

and persistent in the field over several weeks, with little sign of decay. Known from the type locality in the Upper Potaro River Basin and adjacent Ireng River Basin of Guyana.

Representative specimens examined. GUYANA. Region 8: Potaro-Siparuni. Pakaraima Mountains. Upper Ireng River Basin, west slope of Kukuinang Mt., two km east of confluence of Sukabi and Ireng Rivers, elevation 1000 m, May 23, 1998, *Henkel* 6556 (BRG; HSU). Upper Potaro River Basin, ~ 20 km east of Mt. Ayanganna, environs of base camp located on Potaro River one km upstream from confluence with Whitewater Creek at 5° 18′ 04.8″ N, 59° 54′ 40.4″ W, elevation 710–750 m: at Potaro base camp, 26 May 2000, *Henkel 7432* (BRG, HSU); vicinity of base camp, 23 June 2000, *Henkel* 7550 (BRG, HSU); at base camp, 18 June 2000, *Henkel 7515* (BRG; HSU); 3 km SW of base camp located at 5° 18′ 04.8″ N, 59° 54′ 40.4″ W, elevation 710 m, in *Dicymbe* plot 3, 2 June 2001, *Henkel 8235* (HOLOTYPE, BRG; ISOTYPE: HSU, NY);1 km southwest of base camp on trail to *Dicymbe* plot 3, 27 June 2006, *Aime 3107* (BRG; LSU).

Comments — On the basis of its infundibuliform, perforate, subcoriaceous basidiomata arising from acuminate primordia with straight margins *C. excelsus* can be identified as a species in *Craterellus* in both the traditional and modern senses (Corner 1966, Feibelman et al. 1997, Dahlman et al. 2000, Henkel et al. 2006, Moncalvo et al. 2006). This identification is corroborated by the smooth, thickening hymenium, the long, narrow basidia bearing 2–6 curved sterigmata, the white, smooth, thin-walled, inamyloid basidiospores, and monomitic tramal hyphae lacking clamp connections and secondary septations (Corner 1966).

Because of its broadly undulate to crenate, lobed basidioma margin and similarly-sized basidiospores *C. excelsus* resembles the Venezuelan *C. orinocensis*. However, *C. orinocensis* can be distinguished from *C. excelsus* by its brownish fuliginous, shorter basidiomata (≤ 80 mm) with rugose-striate hymenia and shorter (55–60 µm), consistently 6-sterigmate basidia (Corner 1966, Singer et al. 1983).

Craterellus verrucosus from Malaysia has the caespitose habit, a light grey hymenium, a thin, pliant context, and basidiospores similar in size to those of *C. excelsus*. *Craterellus verrucosus* can be distinguished from *C. excelsus* by its fuscous fuliginous to black basal stem, shorter basidiomata (30–70 mm), shorter, subclavate basidia (55–95 µm), and more inflated tramal hyphae (up to 25 µm wide) (Corner 1966).

The north temperate *Craterellus cornucopioides* var. *cornucopioides* is phenetically similar to *C. excelsus* with caespitose basidiomata occasionally reaching 150 mm in height and basidia approaching 100 µm in length, but can be distinguished by its regularly bisterigmate basidia and fuliginous black basidiomata with cinereous hymenia (Corner 1966). The European *C. cornucopioides* var. *flavicans* and *C. cornucopioides* var. *roseus* are distinguished by light yellow or rosaceous hymenia, respectively. In the tropics *C. cornucopioides* var. *mediosporus* from Malaysia has 4–6 sterigmate basidia and basidiospores similar in size to those found in *C. excelsus*, but is distinguished

by its fuliginous black basidiomata (Corner 1966). *Craterellus cornucopioides* var. *parvisporus* from the Congo has smaller spores (6.8–8.5 × 4.3–6 µm) than *C. excelsus*, regularly 4-sterigmate basidia, and blackish brown basidiomata (Heinemann 1959).

Pseudocraterellus sinuosus, which is superficially similar to *C. excelsus* in basidioma stature and coloration and has been recorded from the Guiana Shield region (Corner 1969), is easily distinguished by its copiously secondarily septate hyphae forming moniliform rows of cells in the trama (Corner 1966).

Craterellus excelsus is an excellent edible fungus, but traditionally it was not used by the Patamona Amerindians of the Pakaraima Mountains (Henkel et al. 2004). Confirmation of its edibility by visiting mycologists has led to recent incorporation of *C. excelsus* into the assemblage of nearly 20 species of macrofungi regularly gathered and consumed by the Patamona (T.H., pers. obs.).

Acknowledgments

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Two new lichenicolous *Arthonia* species from Turkey

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Abstract — Two new *Arthonia* species are described from Turkey: *A. epitoninia* on the squamules of an unidentified *Toninia* sp., and *A. rinodinicola* on the areoles of *Rinodina gennarii*. Previously, no *Arthonia* species were reported from these host genera.

Key words — *Ascomycota*, lichenicolous fungi, lichens, taxonomy

Introduction

In the course of investigating the lichenicolous fungi kept at ANES (Herbarium of Anadolu University), several new species were described and many new records for Turkey published in separate publications (Candan & Halıcı 2008, Halıcı & Candan 2007, Halıcı et al. 2007a,b, 2008). Approximately 130 infrageneric taxa of lichenicolous fungi are known from Turkey (Candan & Halıcı 2008, Halıcı 2008a,b,c), and a key to the lichenicolous *Ascomycetes* including mitosporic fungi was recently published by Halıcı (2008a). Here we describe two new lichenicolous species of *Arthonia* from the ANES collections.

Material and methods

The types of the new species are deposited in ANES (Anadolu University, Department of Biology, Eskişehir). Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics and a drawing tube. Sections were prepared by hand and examined in I (Lugol's iodine (MERCK 9261) and Meltzer's iodine, with [KI] and without [I] pre-treatment with 10% KOH), 10% KOH, and water. Ascospore measurements were taken in water; the extreme values outside the main range are given in

parentheses. The length/breadth (l/b) ratio of the ascospores is provided in the same way.

The species

Arthonia epitoninia Halici & Candan, **sp. nov.** FIGURE 1

MycoBank MB 512548

Fungus in thallo Toniniae sp. incolens. Apothecia nigra, 0.2–0.5 mm diam. Epithecium 10–20 μm altum, olivaceo-brunneum. Hymenium 40–50 μm altum, hyalinum. Hypothecium 15–25 μm altum, brunneum. Asci (33–)34.5–46.5(–50) × (16.5–)18–24(–27) μm, clavati-obovati, octospori. Ascosporae 1-septatae, hyalinae, halonatae, (11–)13–16 × 5–6 μm, l/b = (2.2–)2.4–2.7(–3.0).

Typus: Turkey, Ankara, Bala District, south of Beynam Village, 39°41'N, 32°55'E, alt. 1450 m, on squamules of *Toninia* sp. on soil, 2 July 2003, leg. M. Candan (ANES 11.537 – holotypus).

Etymology: The epithet "*epitoninia*" refers to the host *Toninia*.

Description: Lichenicolous, on the squamules of *Toninia* sp., causing heavy discolouration and suppressing ascomata production in the host, heavily parasitic. Ascomata apothecia, dispersed on the surface of the host squamules, black, epruinose, superficial, 0.2–0.5 mm diam, 1–4 per squamule, lacking an exciple, arthonioid. Epithecium dark brown with an olivaceous tinge, 10–20 μm tall, K+ greenish, N–; hymenium with numerous oil droplets, colourless, 40–50 μm tall, I_{Lugol}–, KI_{Lugol} –, $I_{Meltzer}$ –; hypothecium dark brown to blackish brown, 15–25 μm tall. Hamathecium of abundant, septate, branched and anastomosed paraphysoids, 2–2.5 μm wide, with markedly swollen, olivaceous brown apices, to 4–5.5 μm wide. Asci broadly clavate to obovate, short-stalked, bitunicate in structure, 8-spored, I_{Lugol}–, KI_{Lugol}–, without a KI_{Lugol}+ blue apical ring, (33–)34.5–46.5(–50) × (16.5–)18–24(–27) μm. Ascospores irregularly arranged in the asci, mostly overlapping, ellipsoid, hyaline, 1–septate, rounded to somewhat broadly pointed at the apices, slightly constricted at the septa, the upper cell slightly larger than the lower one, with one droplet per cell, surrounded by a I_{Lugol}–gelatinous sheath, (11–)13–16 × 5–6 μm (*n* = 36), l/b = (2.2–)2.4–2.7(–3.0), all measurements including the closely adhering sheath. Conidiomata not observed.

Ecology and distribution: Heavily parasitic on the squamules of *Toninia* sp. causing heavy discolouration and suppressing ascomata production in the host. The new species is known only from one locality in central Turkey. As the host genus has a wide distribution in the Northern Hemisphere, the species should be searched elsewhere.

Observations: *Arthonia epitoninia* is most similar to *A. almquistii* Vain., a lichenicolous species known on *Amygdalaria panaeola*, *A. pelobotryon*, *Porpidia crustulata* and *Trapelia coarctata*. However, *A. almquistii* is well distinguished

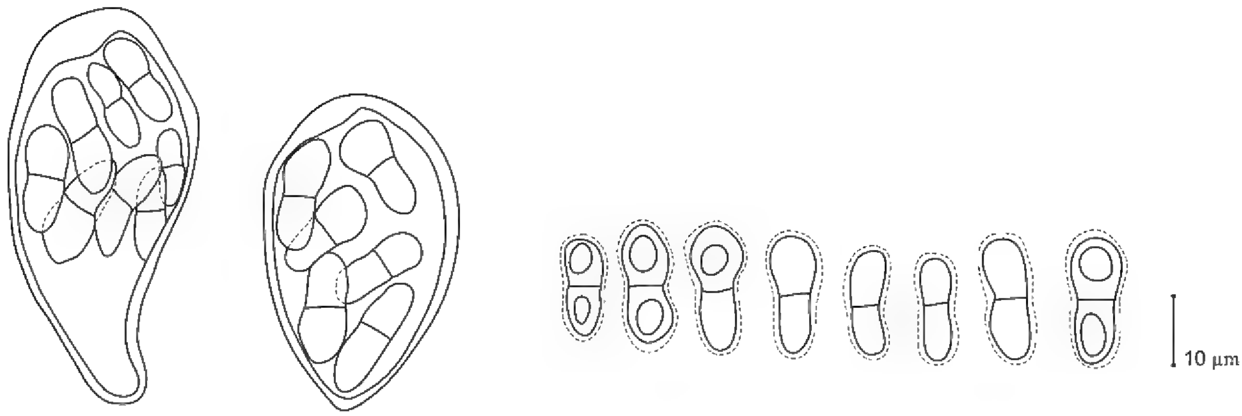

FIG. 1. ***Arthonia epitoninia*** (holotype). Asci and ascospore outlines.

from *A. epitoninia* by having mature ascospores with gelatinous sheath stained red by I_{Lugol}, and a I_{Lugol}+ red hymenium (Triebel 1989). *A. oligospora* Vĕzda, a lichenicolous species known on the thallus of *Aspicilia* sp. (Candan & Halıcı 2008) and on the thalli of a saxicolous, calcicolous lichen (Clauzade et al. 1989), differs from *A. epitoninia* by having constantly 4-spored asci (Clauzade et al. 1989, Candan & Halıcı 2008). *A. epimela* (Norman ex Almq.) I.M.Lamb, a lichenicolous species on *Amandinea punctata* has narrower ascospores [3.5–4.5 µm vs. 5–6 µm broad] and an I_{Lugol} + red hymenium (Almquist 1880, Clauzade et al. 1989).

Arthonia rinodinicola Candan & Halici, **sp. nov.** FIGURE 2

MYCOBANK MB 512549

Fungus in thallo Rinodinae gennarii incolens. Apothecia nigra, 0.1– 0.2 mm diam. Epithecium 10–20 µm altum, brunneum. Hymenium 35–45 µm altum, hyalinum. Hypothecium 20–30 µm altum, brunneum. Asci (24–)25–34(–35) × (17–)17.5–19(–20) µm, clavati-obovati, octospori. Ascosporae 1-septatae, hyalinae sed demum brunneum, 10–13(–14) × (4–)4.5–5.5(–6) µm, l/b = (1.8–)2.0–2.6(–2.9).

TYPUS: Turkey, Malatya, Arguvan, north of İçmece Village, 38°44'N, 38°25'E, alt. 871 m, on *Rinodina gennarii* on calcareous rock, 03 Aug 2004, leg. M. Candan (ANES 11.543 – holotypus).

ETYMOLOGY: The epithet "*rinodinicola*" refers to the host *Rinodina*.

DESCRIPTION: Lichenicolous, on the areoles of *Rinodina gennarii*, not causing any evident damage, parasymbiotic. ASCOMATA apothecia, dispersed on the surface of the host areoles, black, epruinose, superficial, 0.1–0.2 mm diam, 1–3 per areole, lacking an exciple, arthonioid. Epithecium dark brown, 10–20 µm tall, K+ greenish, N–; hymenium colourless, 35–45 µm tall, I_{Lugol} –, KI_{Lugol}–, $I_{Meltzer}$–; hypothecium dark brown to blackish brown, 20–30 µm tall. HAMATHECIUM of paraphysoids, abundant, septate, branched and anastomosed, 1.5–2.0 µm wide; markedly swollen apices, reddish brown, to 3.5–4.5 µm wide. ASCI broadly clavate to obovate, short-stalked, bitunicate in structure,

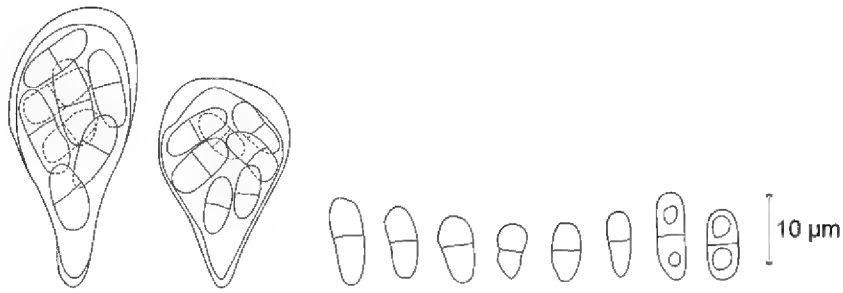

FIG. 2. ***Arthonia rinodinicola*** (holotype). Asci and ascospore outlines.

8-spored, I_{Lugol}–, KI_{Lugol}–, without a KI_{Lugol}+ blue apical ring, (24–)25–34(–35) × (17–)17.5–19(–20) µm. ASCOSPORES irregularly arranged in the asci, mostly overlapping, ellipsoid, hyaline, soon becoming brown, 1-septate, rounded to somewhat broadly pointed at the apices, slightly constricted at the septa, the upper cell slightly larger than the lower one, with one droplet per cell in mature ascospores, without a gelatinous sheath, 10–13(–14) × (4–)4.5–5.5(–6) µm (n = 36), l/b = (1.8–)2.0–2.6(–2.9). CONIDIOMATA not observed.

ECOLOGY AND DISTRIBUTION: Parasymbiotic on the areoles of *Rinodina gennarii*, not causing any evident damage to the host. The new species is known only from one locality in eastern Turkey. As the host species (sometimes considered a synonym of *Rinodina oleae*) has a wide distribution in the Northern Hemisphere, this new *Arthonia* should be searched for elsewhere.

OBSERVATIONS: The size, shape and colour of the ascospores of *Arthonia rinodinicola* is most similar to *A. cohabitans* Coppins, a lichenicolous species described on *Arthothelium reagens* (Coppins 1989). However, *A. cohabitans* is easily distinguished from the new species by having a K+ purple reaction of the ascomatal sections due to a yellow-orange pigment (Coppins 1989). Another lichenicolous species of *Arthonia*, *A. punctella* Nyl., has also brown ascospores when mature, but they are warted and bigger [12–17 × 5–6.5(–7.5) µm vs. 10–13(–14) × (4–)4.5–5.5(–6) µm] (Coppins 1992). The ascospore size is similar to *A. almquistii*, a lichenicolous species known on *Amygdalaria panaeola*, *A. pelobotryon*, *Porpidia crustulata* and *Trapelia coarctata*, but the ascospores are never brown in that species and the gelatinous sheath of mature ascospores is stained red by I_{Lugol} (Triebel 1989).

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Three new species of *Exobasidium* (*Exobasidiales*) from China

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Abstract—Three new species, *Exobasidium kunmingense* on *Lyonia ovalifolia*, *Exobasidium lushanense* on *Rhododendron simsii* and *Exobasidium rhododendri-russati* on *R. russatum*, are reported from Yunnan and Jiangxi Provinces. *Exobasidium kunmingense* and *E. lushanense* cause leaf spots on leaves and *E. rhododendri-russati* causes small galls on leaves and stems.

Key words—*Ustilaginomycetes*, symptoms, taxonomy

According to Nannfeldt (1981), the number and size of sterigmata, the size of basidiospores and the germination form are used for the identification species of *Exobasidium*.

The first new species was collected from Yunnan Province in 2007. It is parasitic on *Lyonia ovalifolia*, causing leaf spots, concave on the lower surface. The leaf spot is red and about 4.5–15 mm in diam. There are one or more diseased parts on each leaf. The host plant belongs to the subfamily *Andromedoideae* of *Ericaceae*. Transverse sections of the diseased leaf show neither hypertrophy nor hyperplasia of plant cells. Hyphae protrude between epidermal cells, forming a continuous thick layer on the lower surfaces of the leaves at maturity. It is described as:

Exobasidium kunmingense Zhen Ying Li & L. Guo, **sp. nov.** Figs. 1, 4-5

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Hymenium hypophyllum. Basidia cylindrica, 4–6 µm lata, hyalina, terminaliter 3–6 sterigmatibus 3–4 × 1–1.2(–1.8) µm praedita. Basidiosporae cylindricae, 12–17 × 3–4 µm, hyalinae, laeves, curvae, primo continuae, dein 1(–3)-septatae, per hyphas germinantes.

*corresponding author

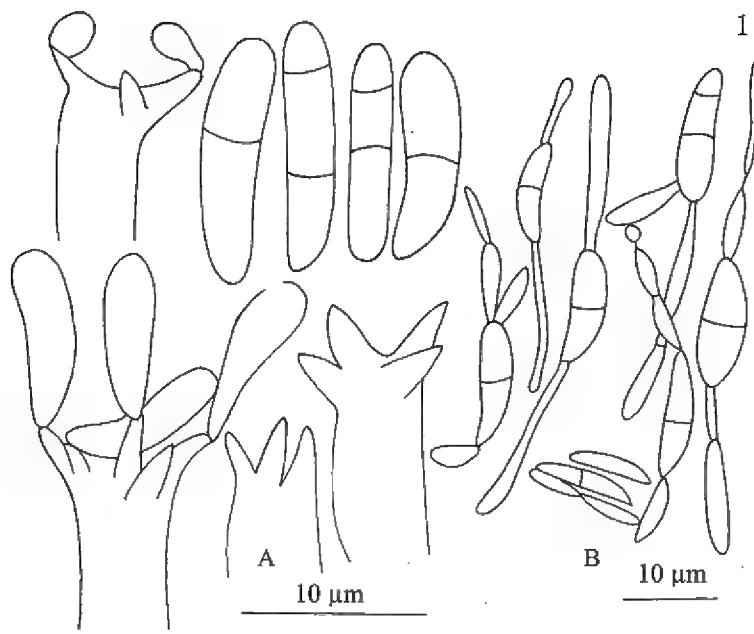

Fig. 1. Line drawings of *Exobasidium kunmingense* on *Lyonia ovalifolia* (HMAS 173147, holotype). A. Basidia, sterigmata and basidiospores. B. Basidiospore germination.

Hymenium hypophyllous. Basidia cylindrical, 4–6 μm wide, hyaline, with 3–6 sterigmata. Sterigmata conical, 3–4 × 1–1.2(–1.8) μm. Basidiospores cylindrical, 12–17 × 3–4 μm, hyaline, smooth, at first continuous, then 1(–3)-septate, slightly curved, germinating by short germ tubes.

Specimen examined—On *Lyonia ovalifolia* (Wall.) Drude (*Ericaceae*), Yunnan: Luquan, Zhelaocun, alt. 2520 m, 1 VII 2006, Z.Y. Li & L. Guo 335, HMAS 173147 (**holotype**).

Colonies on PDA grew gradually to a maximum 9 mm diameter in 21-day incubation at 25°C. The colony was leathery, pale yellow and corrugate on the surface, mainly composed of conidia. Conidia bacilliform and 5–9 × 1–1.2(–1.8) μm.

Exobasidium kunmingense is similar to *E. lyoniae* Zhen Ying Li & L. Guo (Li & Guo 2006a) from which it mainly differs in the number of sterigmata (3–6 vs. 2–5).

The second new species was collected from Jiangxi Province in 2007. It is parasitic on *Rhododendron simsii*, causing leaf spots. There are one or more diseased parts on each leaf. The host plant belongs to the subfamily *Rhododendroideae* of *Ericaceae*. Transverse sections of the diseased leaf show hypertrophy of plant cells. Hyphae protrude between epidermal cells, forming a continuous thick layer on the lower surface of the leaves at maturity. It is described as:

Exobasidium lushanense Zhen Ying Li & L. Guo, **sp. nov.** **Figs. 2, 6-7**

MycoBank MB 512326

Hymenium hypophyllum. Basidia cylindrica, 36–60 × 5.5–7 μm, hyalina, terminaliter (2–)3–6 sterigmatibus 3–4 × 1–1.5 μm praedita. Basidiosporae cylindricae vel clavatae,

(7.2–)9–13(–15) × 3–4 µm, hyalinae, laeves, primo continuae, dein 1–3-septatae, curvae, per hyphas germinantes.

Hymenium hypophyllous. Basidia cylindrical, 36–60 × 5.5–7 µm, hyaline, with (2–)3–6 sterigmata. Sterigmata conical, 3–4 × 1–1.5 µm. Basidiospores cylindrical or clavate, (7.2–)9–13(–15) × 3–4 µm, hyaline, smooth, at first continuous, then 1–3-septate, and slightly curved, germinating by germ tubes.

Specimen examined—On *Rhododendron simsii* Planch. (*Ericaceae*), Jiangxi: Lushan Botanical Garden, alt. 1100 m, 14 V 2007, Z.Y. Li & L. Guo 631, HMAS 173148 (**holotype**).

Colonies on PDA grew gradually to a maximum 10 mm diameter in 21-day incubation at 25°C. The colony was leathery, pale yellow and smooth on the surface, mainly composed of hyphae.

Exobasidium lushanense is similar to *E. japonicum* Shirai (Shirai 1896, Ezuka 1990) from which it mainly differs in causing leaf spots, while *E. japonicum* causes leaf hypertrophy and deformation.

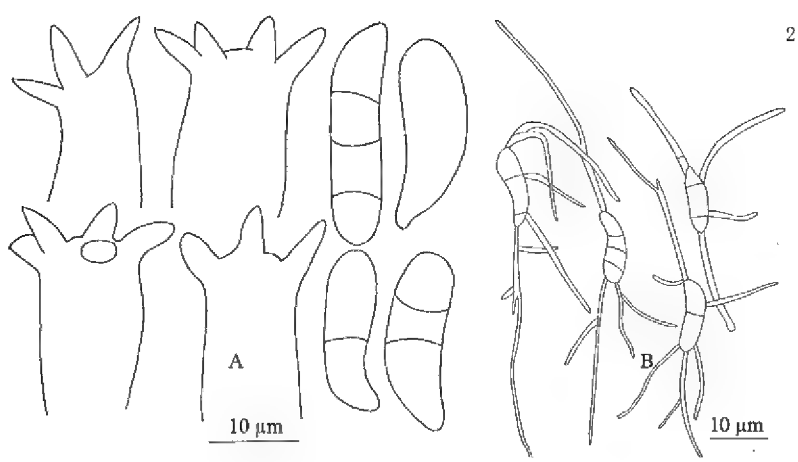

Fig. 2. Line drawings of *Exobasidium lushanense* on *Rhododendron simsii* (HMAS 173148, holotype). A. Basidia, sterigmata and basidiospores. B. Basidiospore germination.

The third new species parasitizes on young leaves of *Rhododendron russatum*, causing small galls on leaves and stems. Transverse sections of the diseased leaf show hypertrophy and hyperplasia of plant cells. Hyphae protrude between epidermal cells, forming a continuous thick layer on the surfaces of the galls at maturity. There are 2–3(–4) sterigmata per basidium.

Exobasidium rhododendri-russati Zhen Ying Li & L. Guo, **sp. nov.** **Figs. 3, 8-9**

MycoBank MB 512327

Hymenium album. Basidia cylindrica or clavata, 13–30 × 4–6 µm, hyalina, terminaliter 2–3(–4) sterigmatibus (2–)4.5–5.5 × 1–2 µm praedita. Basidiosporae cylindricae vel ellipsoideae, 11–16 × 2–3 µm, hyalinae, laeves, primo continuae, dein 1–3(–5)-septatae, curvatae, per hyphas germinantes.

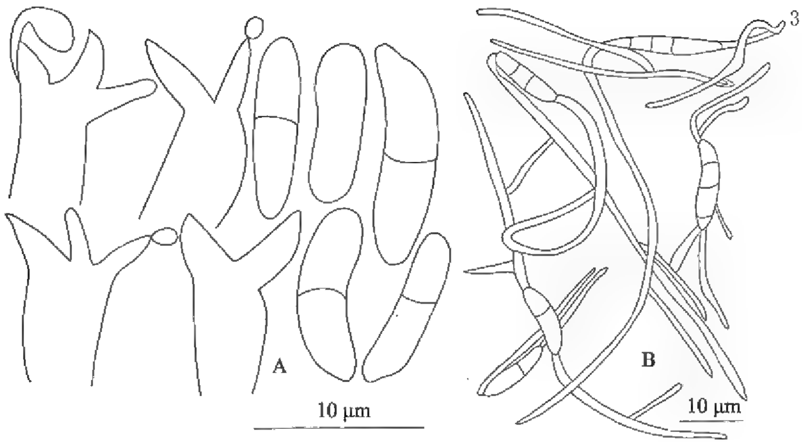

Fig. 3. Line drawings of *Exobasidium rhododendri-russati* on *Rhododendron russatum* (HMAS 183433, holotype). A. Basidia, sterigmata and basidiospores. B. Basidiospore germination.

Hymenium white. Basidia cylindrical or clavate, 13–30 x 4–6 µm, hyaline, with 2–3(–4) sterigmata. Sterigmata conical, (2–)4.5–5.5 × 1–2 µm. Basidiospores cylindrical or ellipsoidal, 11–16 × 2–3 µm, hyaline, smooth, at first continuous, then 1–3(–5)-septate, slightly curved, germinating by germ tubes.

Specimen examined—On *Rhododendron russatum* Balf. f. & Forrest (*Ericaceae*), Yunnan: Xianggelila, Yisicun, alt.3300 m, 26 IX 2007, Z.Y. Li, L. Guo & S. H. He 724, HMAS 183433 (**holotype**).

Colonies on PDA grew gradually to a maximum 10 mm diameter in 21-day incubation at 25°C. The colony was leathery, yellow and corrugate on the surface, mainly composed of conidia. Conidia linear, 6–17 x 0.5 µm.

Exobasidium rhododendri-russati is similar to *E. rhododendri-nivalis* Zhen Ying Li & L. Guo (Li & Guo 2008c) on *Rhododendron nivale* Hook. f. from which it mainly differs in having larger basidiospores (11–16 × 2–3 vs. 10.2–13 × 2.5–3 µm).

To date, 32 species of *Exobasidium* have been recorded in China (Sawada 1922, Teng 1963, Tai 1979, Guo et al. 1991, Zang 1996, Li & Guo 2006a, b, 2008a, b,c) including the three new species in this paper.

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Figs. 4–5. *Exobasidium kunmingense* on *Lyonia ovalifolia* (HMAS 173147, holotype). Fig. 4. Symptoms. Fig. 5. Basidium, sterigmata and basidiospores as seen by SEM. **Figs. 6–7.** *Exobasidium lushanense* on *Rhododendron simsii* (HMAS 173148, holotype). Fig.6. Symptoms. Fig. 7. Basidium, sterigmata and basidiospores as seen by SEM. **Figs. 8–9.** *Exobasidium rhododendri-russati* on *Rhododendron russatum* (HMAS 183433, holotype). Fig. 8. Symptom. Fig. 9. Basidium, sterigmata and basidiospores as seen by SEM.


4
5
Mag HV Det Spot 10.0µm
6
7
07 WD Mag HV Det Spot 5.0µm
8
9
Det WD Mag Pressure HFW 5.0µm

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MYCOTAXON

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A checklist of xylophilous basidiomycetes (*Basidiomycota*) in mangroves

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Abstract — Based on intensive search of literature records of xylophilous basidiomycetes in mangroves, a list with 112 species is presented. These species are distributed in 63 genera, 27 families and 9 orders. *Polyporaceae* is the most represented family with 33 species; *Phellinus* is the genus with the highest number of species (7). Brazilian mangroves, with 55 species, are the best known areas. The most frequent host is *Rhizophora mangle* with 34 species recorded on it. For each species the localities and substrates are provided, when these data were available in the respective original article. The complete checklist is available on http://www.mycotaxon.com/ resources/weblists.html.

Key words — *Agaricales*, *Aphyllophorales*, *Auriculariales*, mycodiversity

Introduction

Mangroves are transitional coastal ecosystems situated at the confluence of land and sea (Alongi 2002). Their distribution is closely related to basic features of the marine environment, mainly salinity (Chapman 1977). The atmospheric temperature also influences the distribution of mangroves and they are found mostly in the tropics; however under special climatic conditions they occur in subtropical regions, such as Japan and the State of Santa Catarina in Brazil (Cintrón & Schaeffer-Novelli 1980).

Although tropical forests typically have a high diversity of plant species, mangroves are low diversity ecosystems and there are roughly 70 species of mangroves plants (Alongi 2002). The most diverse regions border the Pacific Ocean and west Indian Ocean (Cintrón & Schaeffer-Novelli 1980).

Mangrove species diversity is well known for animals and plants, but poorly known for other organisms such as fungi (Macintosh & Ashton 2002). The study of mangrove fungi began in the 1950's in Australia; however fungal species were reported from these ecosystems earlier by authors who did not study particularly the manglicolous mycota (Schmit & Shearer 2003). The data

Figure 1. Mangrove Forest of Itacorubi, Santa Catarina, Southern Brazil (photo by L. Trierveiler-Pereira).

on mangrove fungi refer mainly to 'marine fungi', which grow and sporulate exclusively in marine or estuarine habitats (Kohlmeyer & Kohlmeyer 1979). In contrast, little is known about terrestrial fungi in mangrove forests (Hyde & Lee 1995).

The most extensive surveys of mangrove xylophilous basidiomycetes focus on corticioid fungi taxonomy (Maekawa et al. 2003, 2005) or polypore ecology (Gilbert & Sousa 2002, Gilbert et al. 2008). A remarkable number of species are recorded from Northern Brazilian mangroves due to the research of Campos et al. (2003) and Sotão et al. (1991, 2002, 2003). Other records correspond to isolated citations in several articles that have not focused exclusively on mangrove xylophilous basidiomycetes.

The objective of the present work is to compile data on mangrove xylophilous basidiomycetes and to present a list of species with the locality and substrate of each one.

Material and methods

This checklist has been compiled based on an intensive search of literature records of xylophilous basidiomycetes in mangroves. Nomenclature, taxonomic position, and author names followed the databases: Index Fungorum – IFS (http://www.indexfungorum.org/Names/Names.asp) and

FIGURE 2. Basidiomata of *Schizophyllum commune* growing on dead trunk of *Avicennia schaueriana* (photo by L. Trierveiler-Pereira).

the International Plant Names Index – IPNI (http://www.ipni.org). Genera and species are listed alphabetically within each family and order. Genera with taxonomic position not well established are placed in 'incertae sedis'. Names not found either on the IFS database or in the literature were placed in a separated section named 'Doubtful names cited from mangroves'. This checklist only includes records identified to the species level.

Although the compiled list was carefully revised, minor errors can occur. We plan to regularly update the internet version of the checklist, so we gratefully encourage any remarks concerning errors or omitted data.

Results

The 112 xylophilous basidiomycetes species reported from mangroves are distributed among 63 genera, 27 families, and 9 orders. The most represented family is *Polyporaceae* with 33 species, followed by *Hymenochaetaceae* with 15 species. The genus with highest number of species is *Phellinus* with seven species, followed by *Trametes* with six species and *Trichaptum* with five species.

The mangrove areas with the highest number of species recorded are located in Brazil (55 species), Micronesia (19), Japan (17) and Puerto Rico (15). Other localities are represented by eight or fewer reported species.

Rhizophora mangle with 34 species recorded is the most common host, followed by *Bruguiera gymnorhiza* (17) and *Sonneratia alba* (15).

The complete checklist is available on http://www.mycotaxon.com/resources/weblists.html.

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Two new anamorphic fungi and some microfungi recorded from 'El Ávila,' Venezuela

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Abstract — Two interesting fungi collected during investigations of microfungi on dead plant material in the mountains range 'Cerro El Ávila', Caracas, Venezuela, are described and illustrated. *Phaeodactylium biseptatum* anam. sp. nov. is distinguished by clavate, fusiform to narrowly ellipsoid, ventricose, 2-septate conidia with central cell

pale brown and subhyaline ends. A key to accepted *Phaeodactylium* species is provided. *Polyschema amoenum* is characterized by moniliform conidiophores and fusiform to navicular, 4–5-septate, smooth conidia, with two dark brown cells, the other conidial cells subhyaline.

Key words — conidial fungi, leaf litter, systematics, tropical rainforest

Introduction

During an expedition in 2006 to "Cerro El Ávila", near Caracas, Venezuela, two conspicuous anamorphic fungi from the genus *Phaeodactylium* and *Polyschema* were collected. Morphologically those fungi were distinctly different from previously described species and are therefore described as new species.

Materials and methods

Samples of plant litter collected in separate paper bags were taken to the laboratory where each was incubated at 25° C in Petri dishes placed inside 50 L plastic moist chambers containing 200 ml sterile water and 2 ml glycerol. Plant material was examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000. Micrographs were obtained with a Zeiss Axioscop 40 microscope. Herbarium specimens were deposited at the Simon Bolivar University (USB) and VEN.

Taxonomy

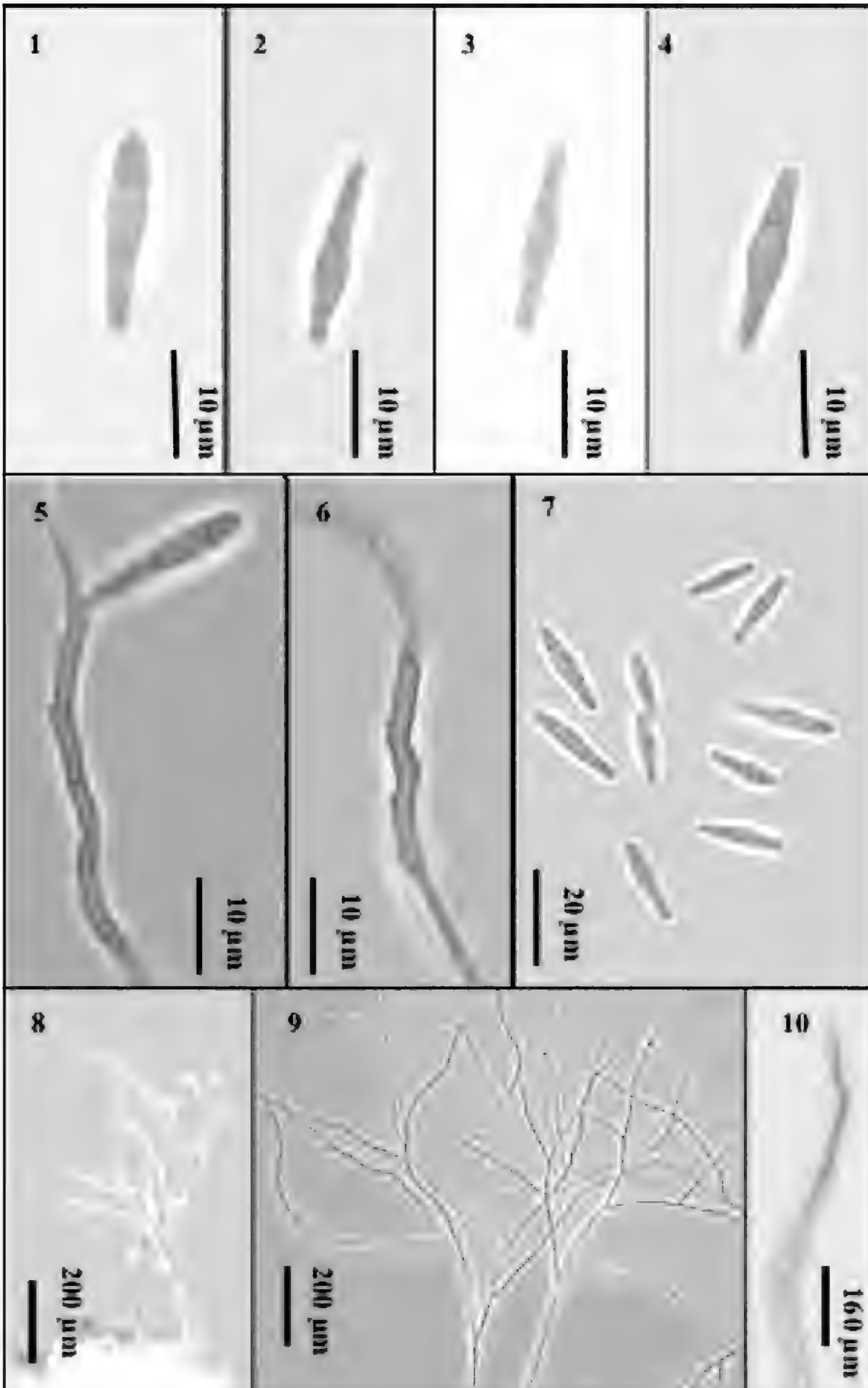
Phaeodactylium biseptatum R.F. Castañeda, Iturr. & Rob. Fernández, **anam. sp. nov.** Figs. 1–12

MycoBank MB 511938

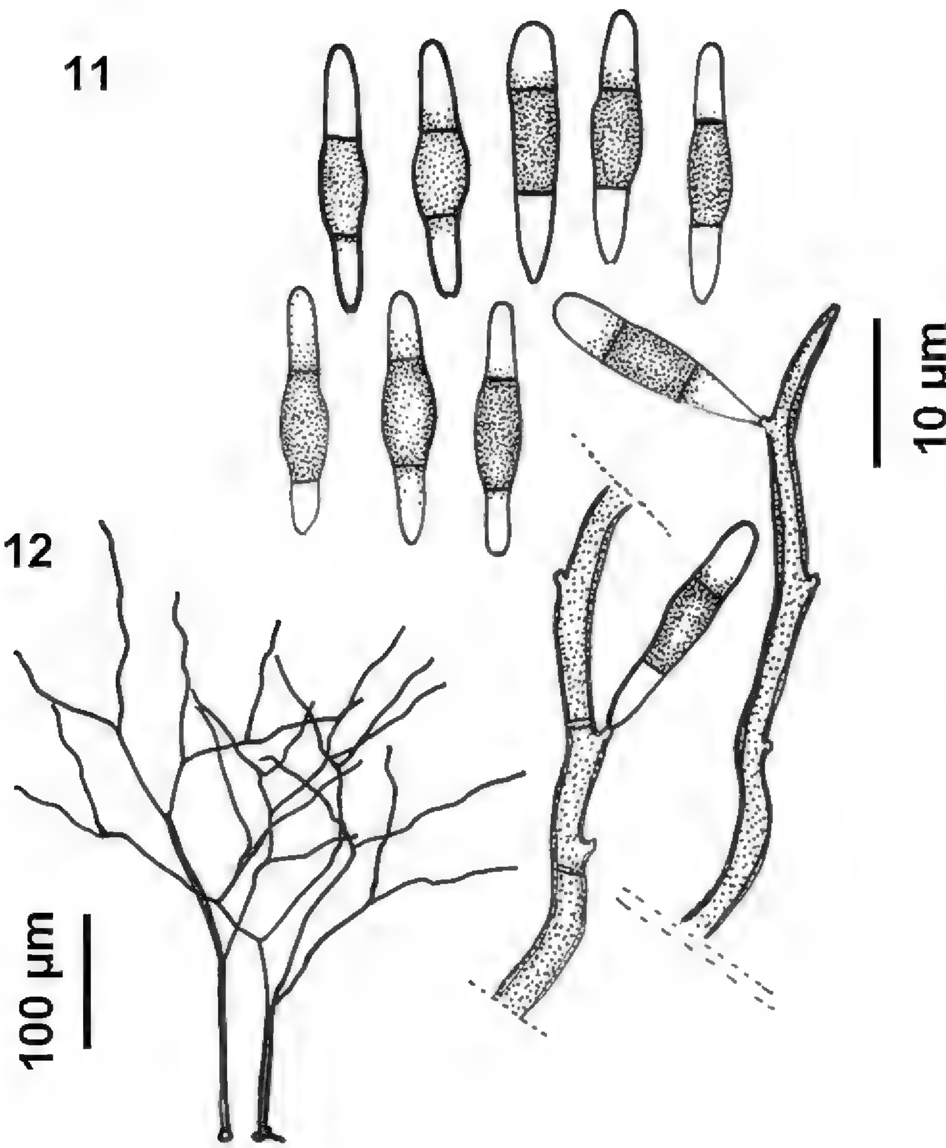
Coloniae in substrato naturali, effusae, pilosae, amphigenae, brunneae ad usque aureo-brunneae. Mycelium partim superficiale et partim in substrato immersum, ex hyphis septatis, ramosis, laevibus, dilute brunneis, 1–2 µm diam. Conidiophora macronemata, mononemata, fasciculata erecta, multi-septata, 350–440 µm altis, 6–7 µm crassis ad basim, brunnea infra, dichotome ramosa; ramis leviter geniculatis, flexuosis, pallide brunneis ad apicem. Cellulae conidiogenae polyblasticae, sympodiales, terminales et intercalares, indeterminatae, cum denticulis cylindricis, manifestis vel interdum inconspicuis praeditae. Secessio conidiorum schizolytica. Conidia solitaria, clavata, fusiformia vel anguste ellipsoidea, plerumque ventricosa ad cellula centralis, biseptata, acropleurogena, laevia, sicca. 10–14 × 2–3 µm, cum cellulis secunda brunneis et cetero dilute brunneis usque ad subhyalinis.

Etymology: Latin, *biseptatum*, referring to the number of conidial septa.

Colonies on the natural substratum effuse, hairy, amphigenous, brown to golden brown. Mycelium superficial and immersed composed of septate, branched, smooth-walled, 1–2 µm diam., pale brown hyphae. Conidiophores



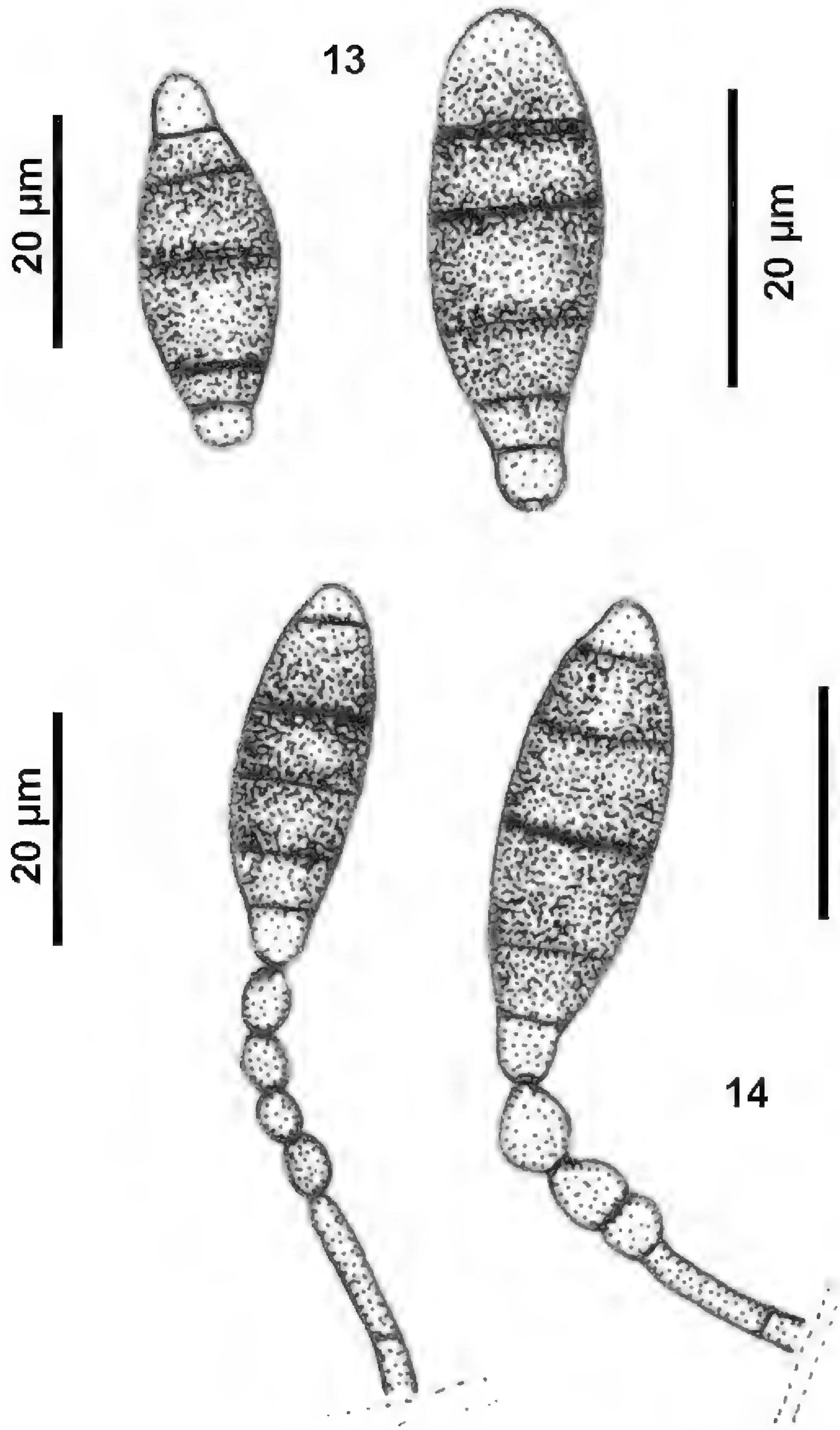
FIGS. 1–10. *Phaeodactylium biseptatum*, photomicrographs from holotype (VEN 395750). FIGS. 1–4, 7. Conidia. FIGS. 5–6. 8,9 Conidiophores and conidiogenous cells. Scale is indicated by bars.



FIGS. 11–12. *Phaeodactylium biseptatum*, drawings from holotype (VEN 395750).
FIG. 11. Conidiophores. FIG. 12. Conidiogenous cells and conidia.
Scale is indicated by bars.

macronematous, mononematous, fasciculate, erect, dichotomously branched, multi-septate, brown at the base, pale brown towards the apex of flexuous, slightly geniculate branches, smooth, 350–440 µm tall, 6–7 µm wide at the base. CONIDIOGENOUS CELLS holoblastic, multilocal, terminal and intercalary, sympodially proliferating, indeterminate, 18.7–35 × 2.0–2.5 µm, with conspicuous or sometimes inconspicuous cylindrical denticles. CONIDIAL SECESSION schizolytic. CONIDIA solitary, clavate, fusiform or narrowly ellipsoid, but mostly equilaterally ventricose at center, 2-septate, acropleurogenous, smooth, 10–14 × 2–3 µm, pale brown to subhyaline ends, but with second cells brown, dry. TELEOMORPH: unknown.

MATRIX: **VENEZUELA, Caracas, "Cerro El Ávila"**, Parque Nacional El Ávila, near "Lagunazo" camping field, on decaying leaf of *Clusia minor* L. 10° 33' N and 66° 51' W, 2243 m alt, 17.VI.2006, coll. R. Fernández. **HOLOTYPE**: VEN 395750.



FIGS. 13–14. *Polyschema amoenum*, drawings from holotype (VEN 395758).
FIG. 13. Conidia. FIG. 14. Conidia still attached to conidiogenous cells.
Scale is indicated by bars.

COMMENTS: The genus *Phaeodactylium* was introduced by Agnihothrudu (1968) with *P. venkatesamum* as type species, but Ellis (1971) considered

this species a synonym of *Dactylium alpiniae* Sawada and made the new combination *P. alpiniae*; this species has clavate, hyaline to subhyaline, 3-septate, 16–25 × 6–9 µm conidia that are distinct from those of *P. biseptatum*. *Phaeodactylium curvularioides* Matsush. (1980) has branched conidiophores which resemble a tree in shape, but the conidia are obovoid, 3-septate, 13–22 × 5–10 µm and lack a ventricose central cell, clearly differentiating it from *P. biseptatum*. Calduch et al. (2002) proposed a new genus *Phaeobotrys* based on *Phaeodactylium acutisporum* Matsush. (1993) and provided a key on related genera with denticulate conidiogenous loci.

Key to accepted *Phaeodactylium* species

1 Conidia 3-septate 2

Conidia 2-septate, clavate, fusiform or narrowly ellipsoid, but slightly ventricose at center, 10–14 × 2–3 µm, smooth, pale brown to subhyaline .... *P. biseptatum*

2(1) Conidia ellipsoidal or clavate, tapered to the base, 16–25 × 6–9 µm, colorless or subhyaline, smooth .... *P. alpiniae*

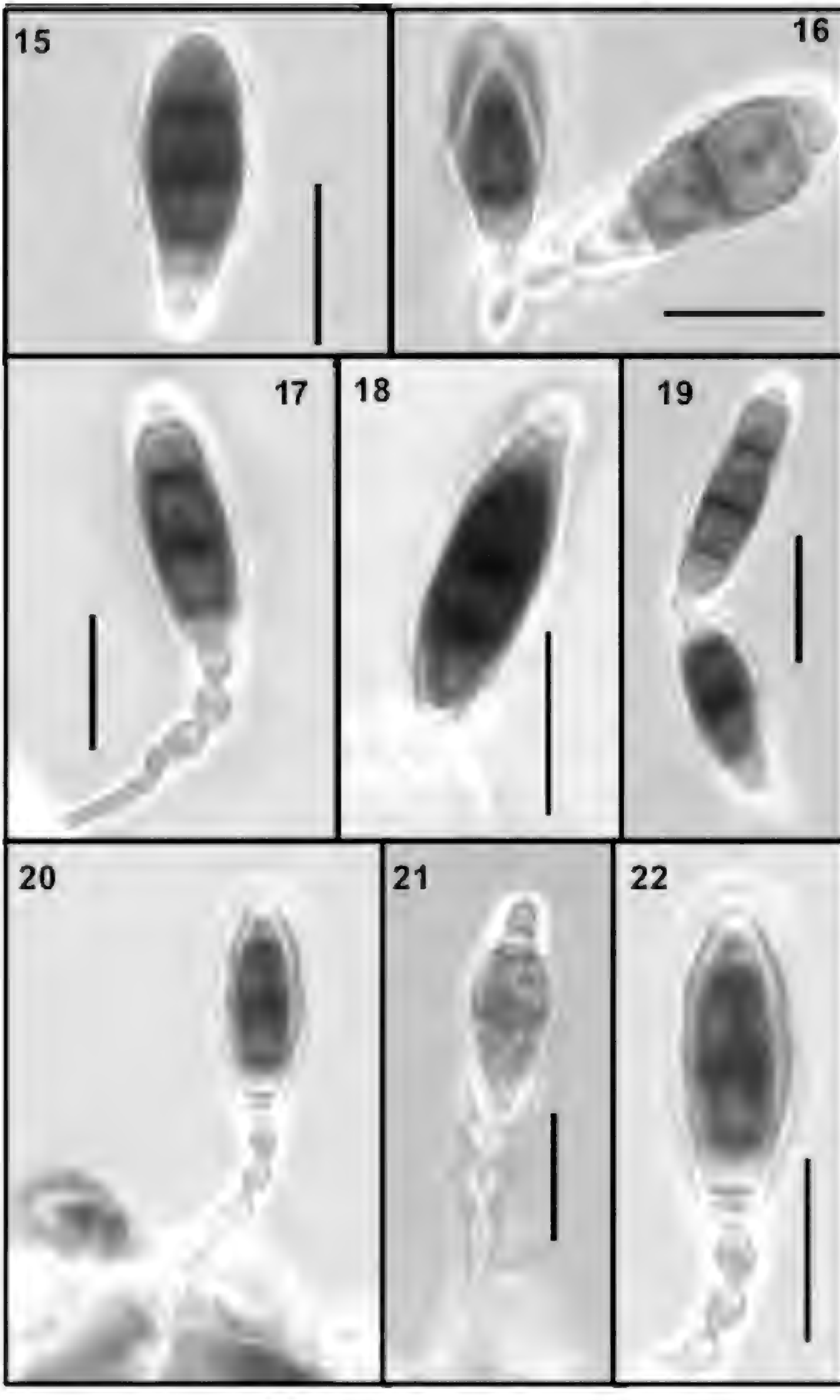
Conidia obovoid, 13–22 × 5–10 µm, with brown median cells and subhyaline ends, smooth .... *P. curvularioides*

Polyschema amoenum R. F. Castañeda, Iturr. & Minter, **anam. sp. nov.** Figs. 13–22
MycoBank MB 511939

Coloniae in substrato naturali effusae, atrobrunneae vel nigrae. Mycelium partim superficiale et partim in substrato inmersum, ex hyphis septatis, ramosis, laevibus, brunneis, 1.5–3.0 µm. Conidiophora semiconspicua, mononemata, erecta vel prostrata, plerumque moniliformia, laevia, 25–50 × 3–4 µm, brunnea. Celulae conidiogenae monotreticae, terminales, globosa, doliiformes ad usque ellipsoidales, determinatae, interdum sympodialiter proliferantes, 5–8 × 3.0–3.5 µm, pallide brunneae, laeves. Secessio conidiorum schizolytica. Conidia solitaria, plerumque, fusiformia usque ad navicularia, raro clavata, plerumque acrogena, interdum acropleurogena, 4- ad 5-septata, laevia, 25–29 × 8–10 µm, atrobrunnea vel nigra ad cellulis centralis et utrimque dilute brunnea, sicca.

Etymology: Latin, *amoenus*, meaning delightful and beautiful, in reference to the appearance of conidia and conidiogenous cells.

Colonies on the natural substrate effuse, dark brown or black. Mycelium superficial and immersed. Hyphae septate, branched, smooth-walled, brown, 1.5–3.0 µm. Conidiophores semi-macronematous, mononematous, erect or prostrate, mostly moniliform towards the apex, smooth-walled, 25–50 × 3–4 µm, brown. Conidiogenous cells monotretic, globose, doliiform to ellipsoid, determinate, terminal, sometimes sympodially proliferating become intercalary, 5–8 × 3.0–3.5 µm, pale brown, smooth-walled. Conidial secession schizolytic. Conidia solitary, mostly fusiform to navicular, rarely clavate, 4- to 5-septate, smooth-walled, 25–29 × 8–10 µm, mostly acrogenous,



Figs. 15–22. *Polyschema amoenum*, photomicrographs from holotype (VEN 395758). Figs. 15, 16, 19. Conidia. Figs. 17, 18, 20–22. Conidia still attached to conidiogenous cells. Scale is indicated by bars.

sometimes acropleurogenous, dark brown to black, but pale brown at end cells, dry. Teleomorph: unknown.

Matrix: **VENEZUELA, Caracas, "Cerro El Ávila"**, Parque Nacional El Ávila, near "Lagunazo" camping field, on twig of unidentified plant. 10° 33' N and 66° 51'W, 2243 m alt, 17.VI.2006, coll. R. Fernández. C06/63-1 = **HOLOTYPE**: VEN 395758.

Comments: Arias et al. (2008) documented the eighteen known species of *Polyschema* and described *P. nigroseptatum* R.M. Arias et al. Three published species of *Polyschema* with smooth, 4–5-septate conidia are: *P. clavulatum* (Cooke & Harkn.) M.B. Ellis, *P. nigroseptatum* and *P. obclaviforme* R.F. Castañeda & Decock (Table 1). None of these species has fusiform to navicular, 25–29 × 8–10 µm conidia such as *P. amoenum*.

Table 1. *Polyschema* species with smooth, 4-5 septate conidia

Species	Conidial shape	Conidial size (µm)
P. clavulatum	clavate	30–46 × 12–16
P. nigroseptatum	clavate to ovoid	41–45 × 19–22
P. obclaviforme	obclavate	30–48 × 6–7

Other microfungi recorded from mountain range "El Ávila", Caracas, Venezuela.

Acrodictys bambusicola M.B. Ellis, Mycol. Pap. 79: 6 (1961).
On twig of unidentified plant, 17.VI.2006, R. Fernández, USB C06/53-1b.

Acumispora phragmospora Matsush., Matsush. Mycol. Mem. 1: 3. (1980)
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/82-2.

Anungitopsis triseptata (Matsush.) R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 35: 12 (1991).
On submerged decaying leaves of unidentified plant, 21.VI.2006, M. Mardones and R. Fernández, USB C06/75.

Arachnophora uberisporoides R. F. Castañeda, W. Gams & Saikawa, Nova Hedwigia 64 (3–4): 479 (1997).
On submerged decaying leaves of unidentified plant, 21.VI.2006, M. Mardones and R. Fernández, USB C06/73.

Arachnophora hughesii R.F. Castañeda & Guarro, Can. J. Bot. 76(9): 1584 (1999) ["1998"].
On twig of unidentified plant, 17.VI.2006, R. Fernández, USB C06/53-1.

Arthrobotrys oligospora Fresen. var. ***oligospora***, Beitrage zur Mykologie 1: 18 (1850).
On worm from soil sample, 17.VI.2006, R. Fernández, USB C06/44

Beltrania querna Harkn., Bull. Calif. Acad. Sci. 1: 39 (1884).
On decaying leaves of unidentified plant, 17.VI.2006, R. Fernández, USB C06/31-7.

Beltraniella havanensis (Hol.-Jech.) Matsush., Matsush. Mycol. Mem. 5: 5 (1987).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/84.

Beltraniella japonica Matsush., Icon. microfung. Matsush. lect. (Kobe): 15 (1975).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/84-1a.

Beltraniella portoricensis (F. Stevens) Piroz. & S.D. Patil, Can. J. Bot. 48(3): 575 (1970).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/103.

Beltraniopsis asperisetifera Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Osaka): 8 (1971).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/85.

Beltraniopsis ramosa R.F. Castañeda, Revta Jardín Bot. Nac., Univ. Habana 6(1): 53 (1985).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena, USB C06/86.

Blastophorum truncatum Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Osaka): 8 (1971).
On decaying leaves of *Clusia rosea* Jacq., 28 .VII. 2006, L. Lucena. C06/82-1.

Brachydesmiella biseptata G. Arnaud ex S. Hughes **var. *biseptata***, Can. J. Bot 39: 1095 (1961).
On dead stems of *Bambusa vulgaris*, 20 .XI. 2007, R. Fernández, USB C07/108.

Brachydesmiella eugecapiellana R.F. Castañeda, Iturr. & Saikawa, Mycotaxon 85: 212 (2003).
On submerged decaying leaves of unidentified plant, 21.VI.2006, M. Mardones and R. Fernández, USB C06/76.

Cacumisporium pleuroconidiophorum (Davydkina & Melnik) R.F. Castañeda, Heredia & Iturr., Mycotaxon 100: 332 (2007).
On submerged twig of unidentified plant, 17.VI.2006, R. Fernández, USB C06/36.

Chaetendophragmia triangularis Matsush. var. ***triangularis***, Microfungi of the Solomon Islands and Papua-New Guinea (Osaka): 12 (1971).
On decaying leaves of unidentified plant, 17.VI.2006, R. Fernández, USB C06/31-4a.

Chaetopsis probosciophora DiCosmo, S.M. Berch & W.B. Kendr., Mycologia 75(6): 962 (1983).
On decaying leaves of unidentified plant, 17.VI.2006, R. Fernández, USB C06/45-5.

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Ramboldia amarkantakana (Lecanoraceae, Ascomycota), a new lichen species from India

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Abstract – The new species *Ramboldia amarkantakana* is characterized by having a whitish, granular thallus, pale orange to dark reddish brown apothecia, 8-spored ascus, and simple, straight to curved ascospores. It is known from the Amarkantak region of central India where it is found on *Shorea robusta*.

Key words – *Pyrrhospora,* Achanakmar, microlichen, deciduous forest

Introduction

During field exploration in the newly established Achanakmar Amarkantak Biosphere Reserve in the central tropical region of India a large number of lichen samples have been collected. The Biosphere Reserve has *Shorea robusta* dominated vegetation and a unique topography of undulating hilly terrain that supports growth of numerous interesting lichen taxa. New and otherwise interesting lichen species reported earlier from the area include *Pertusaria amarkantakana* Preeti Srivast. & D.D. Awasthi, *P. indica* Preeti Srivast. & D.D. Awasthi, *P. rimosa* D.D. Awasthi & Preeti Srivast. (Awasthi & Srivastava 1993), *Caloplaca amarkantakana* Y. Joshi & Upreti (Joshi & Upreti 2006) and *Schadonia indica* Upreti & Nayaka (Upreti & Nayaka 2006). Out of 130 species belonging to 44 genera and 25 families from the Biosphere Reserve (Upreti & Satya 2007), some of the microlichen taxa are currently unidentified as to species. One specimen annotated earlier as *Pyrrhospora* sp. is described here as a new species of *Ramboldia.*

Materials and methods

Thin hand-cut sections of apothecia and thallus were mounted in plain water, cotton blue, 5% KOH and iodine solution and observed under a compound

microscope. For chemical spot tests the usual reagents of K, C and PD were used. TLC was performed in solvent system A following Walker & James (1980).

Taxonomic description

Ramboldia amarkantakana Upreti & Nayaka, **sp. nov.** PLATE 1

MYCOBANK 512597

Thallus corticola, albo-granulato pulverulentus, apothecia ad 2.0 mm diam., convexa, discis pallide, aurantiaco-brunneis et buffobrunneis, pruinosis, hypothecium pallidum vel minus fuscum, K+ violacens, epihymenium fuscum, K+ violacens, sporae hyalinae, ellipsoidae, 14–22 × 3–5.5 µm.

ETYMOLOGY: From the Amarkantak, referring to the type locality.

HOLOTYPUS: INDIA, Madhya Pradesh, Shahdol district, Amarkantak, Dudhara, 2 km away from Kapildhara, alt. 800 m, on bark of *Shorea robusta*, 27th Oct. 1987, Upreti 201737 (LWG–holotype).

THALLUS corticolous, whitish, cream yellow, granular-powdery, forming up to 8 cm patch, 100-180 µm thick, continuous or cracked areolate, granules up to 15 µm diam., medulla 50–70 µm thick. PROTHALLUS blue-black, photobiont *Trebouxia,* cells globose, 5–7 µm diam.

APOTHECIA common, up to 2.0 mm in diam., sessile, constricted at base, proper margin concolourous with thallus irregular-discontinuous, granular, thick when young, excluded when mature, disc pale orange brown to deep reddish brown, rough, plane to strongly convex. EXCIPLE biatorine, 30–50 µm thick when young, indistinct at maturity, eihymenium brown, inspersed with fine granules, K+ purple, hymenium colourless, amyloid, 40–50 µm high, hypothecium pale brown to brown, amyloid, K+ reddish purple, 60–75 µm thick, paraphyses simple or occasionally branched, asci broadly clavate, 8 spored, 25–30 × 8–12 µm; ascospores colourless, ellipsoid, straight to slightly curved, simple, 14–22 × 3–5.5 µm.

CHEMISTRY: Thallus K+ yellow, C–, Pd–; apothecial disc and epihymenium K+ purple, C+ bluish-black to violet, Pd–; hymenium and hypothecium I+ blue, exciple K+ purple. TLC: Atranorin, Haematommone and unidentified lichen substances with purple-brown spt. at rf class 7, pale pink spt. at rf class 2, and light yellow spt. between rf class 4–3.

DISTRIBUTION AND ECOLOGY: *R. amarkantakana* is found growing on *Shorea robusta* tree trunk at a height of 1–1.5 m above ground in moist places near a stream at an altitude of 800 m. The tree bark at this height exhibits a rough, hard and furrowed condition that allows an easy foothold to the lichen where it forms large patches up to 15 cm diam. *S. robusta* is one of the most common trees in the semi-evergreen or deciduous forests in tropical India and an

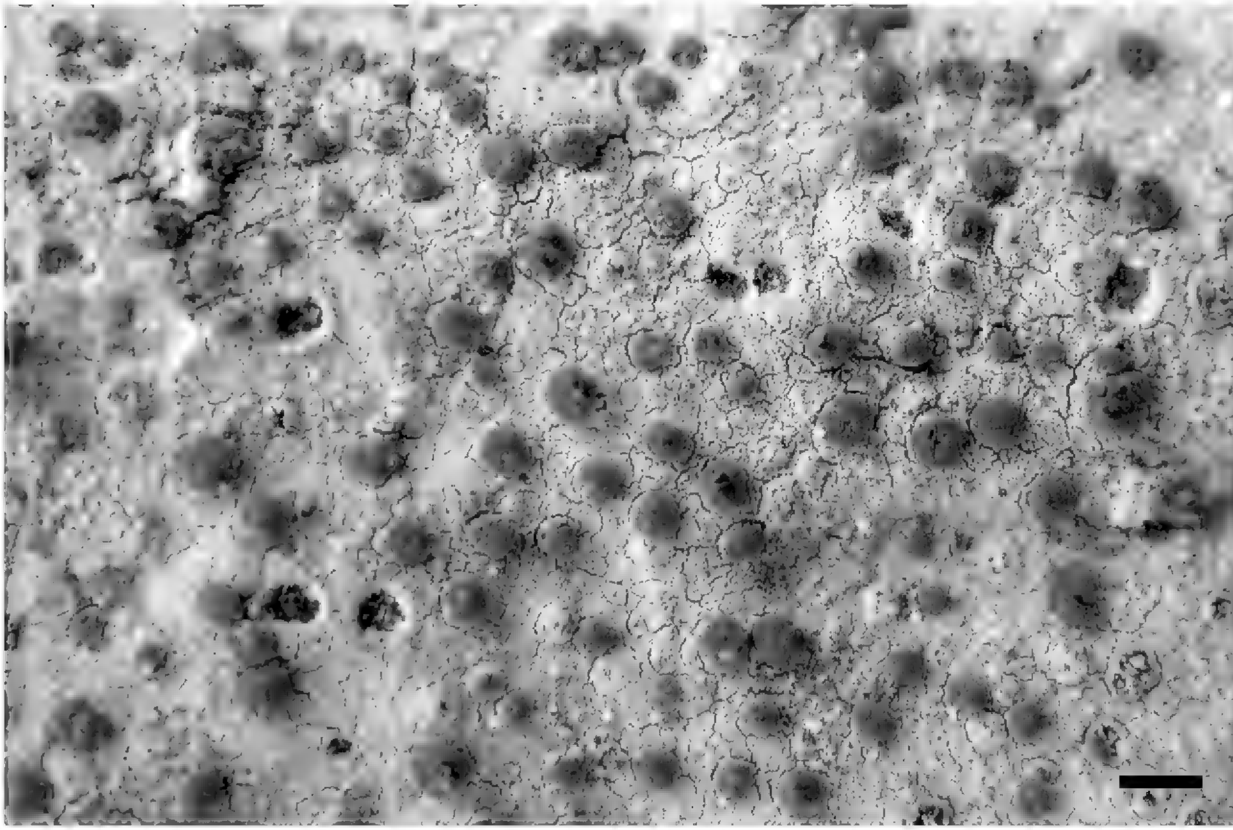

Plate 1. Habit of *Ramboldia amarkantakana* (from holotype, scale bar = 2 mm)

excellent host for several lichens. About 70 species are reported to grow on *S. robusta* in India (Satya et al. 2005). Other common associated species belong to the genera *Lecanora, Buellia, Dirinaria, Heterodermia* and *Pertusaria.*

Remarks: *R. amarkantakana* is characterized by a white to cream yellow, granular, K+ yellow thallus, pale orange to dark reddish brown apothecia, granular, K+ purple, C+ bluish-black to violet and Pd– disc, and 8-spored asci, simple straight to curved ascospores. Kalb et al. (2008) reported the occurrence of *R. manipurensis* (Kr.P. Singh) Kalb et al. in India. *R. manipurensis* differs from *R. amarkantakana* in having 16-spored asci. Similar species in addition to *R. amarkantakana* are *R. aurea* (Kalb & Elix) Kalb et al., *R. aurantiaca* (Aptroot & Diederich) Kalb et al., *R. neolaeta* Kalb & Elix, *R. cinnabarina* (Sommerf.) Kalb et al., and *R. brunneocarpa* Kantvilas & Elix. *R. aurantiaca* differs in having russulone and haematommone as major chemical substances and smaller (8–11 × 3–4 µm) ascospores. *R. neolaeta* differs in having smaller (11–15 × 3–5 µm) ascospores, a grey to greenish grey or dark brownish grey thallus and bright orange-red, glossy, epruinose apothecia. *R. aurea* also differs in having smaller (8–11 × 3–4 µm) ascospores and contains thuringione and arthothelin chemical substances. *R. cinnabarina* differs in having soredia and containing is readily distinguished by the presence of fumarprotocetraric acid. *R. brunneocarpa* differs in having a verruculose and deeply cracked thallus, smaller (9–16 × 2.5–4 µm) ascospores, and the presence of norstictic chemosyndrome.

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A new arenicolous *Boletus* from the Gulf Coast of northern Florida

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Abstract — *Boletus abruptibulbus* sp. nov. is described as new to science. It inhabits old sand dunes in mixed oak-pine stands across the Gulf Coast of northern Florida.

Key words — *Boletaceae*, ectomycorrhizal fungi, taxonomy

Introduction

It is not uncommon to find boletes fruiting in sandy inland soils, especially in Florida. However, in coastal sand dunes only two species of *Boletaceae* have been described from North America: *Phylloporus arenicola* A.H. Sm. & Trappe from Oregon (Smith & Trappe 1972) and *Leccinum arenicola* Redhead & Watling from New Brunswick (Redhead & Watling 1979). To these we add *Boletus abruptibulbus* from the Gulf Coast of the Florida Panhandle.

Materials and methods

Color terms are general approximations, while numerical color designations are from Kornerup & Wanscher (1978). Macro-chemical reaction was determined using NH_4OH. Microscopic structures were observed with an Olympus BH-2 compound microscope, free hand sections of fungal dried material were rehydrated and mounted in H_20, 5% KOH and Melzer's solution. In the description of basidiospores, n = number measured, followed by the mean spore lengths and widths ± their standard deviations and the Q_m value, which represents the mean Q value ± their standard deviation; Q = mean length/width ratio. The herbarium acronym is from Holmgren et al. (1990).

Fig. 1. Basidiomata of *Boletus abruptibulbus*, HOLOTYPE, Both 4588 (BUF).
Scale bar = 15 mm. Photo by WCR.

Taxonomic description

Boletus abruptibulbus Roody, Both & B. Ortiz **sp. nov.** Figs. 1, 2

MycoBank MB 512436

Pileus rubrobrunneus, glaber, siccus vel viscidus in humide, 30-80 mm latus. Contextus albus vel pallide luteus, immutabilis. Tubi flavi, demum olivaceo-viridi, pori concolores. Stipe pallide flavus, bulbosus vel abrupti bulbosus. Basidiosporae 13.5–19.8 × 5–7.2 µm.

Holotype: *Both 4588* (BUF).

Etimology: *abruptibulbus*, abrupt bulb, referring to the abruptly bulbous basal area

Pileus 30–80 mm broad, convex to plano-convex, dry to subviscid when wet, shiny, glabrous, occasionally appressed fibrillose becoming rimulose, pileipellis thin, detersible; reddish brown (8E8) or dark brown (7F8 or 6F8) becoming cinnamon brown (6D6–7); margin incurved when young, becoming decurved when mature, sterile. Pileus trama white to very pale yellow, unchanging when exposed. Odor pleasant, taste mild. Hymenophore tubulose, narrowly depressed near stipe with short decurrent teeth, tubes centrally 3–8 mm long, pale yellow (3A3) at first, becoming pale golden yellow (3A4–5), with age yellowish to greenish olivaceous (3C5 to 3D5), not staining when bruised; pores isodiametric at first, becoming angular to pentagonal in age, sublamellate at the stipe, 1–2 mm broad, concolorous with tubes. Stipe 30–50 mm long, 10–15 mm broad above, 20–25 mm at the bulbous base, equal above, strongly bulbous to abruptly bulbous below, with a strongly developed pseudorhiza 5–15 (–20) mm long, covering with sand adhering to mycelial strands; basal mycelium white; dry, solid, glabrous to minutely pruinose in apical area and there yellow

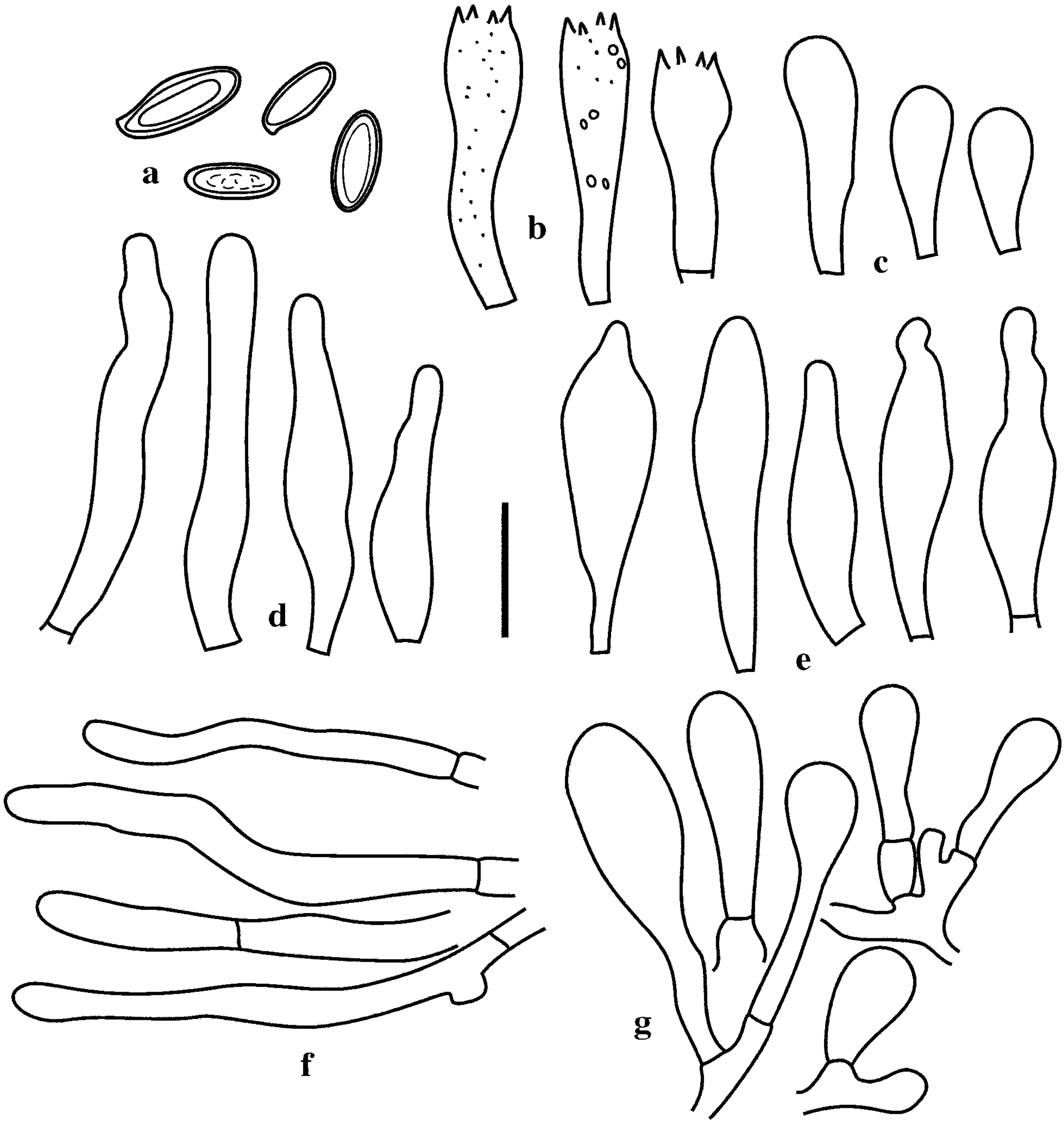

Fig. 2. Microscopic features of *Boletus abruptibulbus*, HOLOTYPE, Both 4588 (BUF).
a. Basidiospores. b. Basidia. c. Basidioles. d. Pleurocystidia. e. Cheilocystidia.
f. Elements of the pileipellis. g. Caulocystidia.
Scale bar = 20 µm.

(3A2–3), gradually and irregularly reddish-concolor with pileus downward, bulbous area with deeper reddish stains, not staining when bruised. Stipe trama solid, pale yellow, larval tunnels reddish brown, unchanging when cut.

Basidiospores 13.5–19.8 (–22.5) × 5–7.2 µm, (n = 20, 15.3 ± 2.39 × 5.8 ± 0.66; Q_m = 2.68 ± 0.26), smooth, fusoid, grayish yellow or greenish yellow in KOH, dextrinoid in Melzer's. Basidia 28.8–42.3 × 7.2–11.7 µm, clavate, hyaline, 4-sterigmate. Basidioles 20.7–35.1 × 7.2–9 µm, clavate. Pleurocystidia 41.4–61.2 × 7.2–10.8 µm, narrowly subfusoid to subcylindric or cylindric, some with an attenuate base, hyaline, smooth and thin-walled. Cheilocystidia

31.5–49.5 × 7.2–13.5 µm, fusoid-ventricose to fusoid, some fusoid-capitate, hyaline, smooth and thin-walled. PILEIPELLIS a tangled layer of repent hyphae 3–13.5 µm, broad, subgelatinous, contents golden yellow in H_2O, becoming grayish yellow in KOH; orange yellow to pale orange brown in Melzer's; end cells cylindrical. TUBE TRAMA boletoid, moderately divergent, grayish yellow in KOH, lateral strata elements 3.6–7.2 µm broad, loose, gelatinized in KOH; mediostratum 27–51 µm wide, subparallel to parallel hyphae 3.6–19 µm broad. PILEUS TRAMA hyphae interwoven, 4.5–22.5 µm broad, hyaline in KOH, yellow in Melzer's, smooth, thin-walled. STIPITIPELLIS hyphae 3.6–13.5 µm broad, subparallel to interwoven, hyaline in KOH, pale orange yellow or grayish yellow in Melzer's. CAULOCYSTIDIA 17.1–51.3 × 7.2–17.1 µm, broadly clavate or clavate, some in clusters, hyaline, thin-walled. CLAMP CONNECTIONS absent.

MACROCHEMICAL REACTIONS: With 12% of aqueous solution of ammonia (NH_4OH) immediately dark red on the pileus surface and on the bulbous base of the stipe on dried material, remaining so for about 15 seconds, and then slowly fading.

ECOLOGY, RANGE DISTRIBUTION: Solitary to gregarious in sand, on older dunes in a transition zone between coastal scrub and oak-pine woods (*Quercus geminata*, *Q. myrtifolia*, *Pinus clausa*). At present only known from the Gulf Coast of the Florida Panhandle. Fruiting from December to March.

MATERIAL EXAMINED: USA. FLORIDA. *Franklin County*: Alligator Point, 7 Dec 2004, W.C. Roody (*Both 4587)* (BUF); Bald Point State Park, 31 Jan 2008, W.C. Roody *(Both 4595)* (BUF); *Gulf County:* Cape San Blas, 19 Dec 2003, W.C. Roody, *(Both 4586)* (BUF); 4 Jan 2005, W.C. Roody, *(Both 4588)* (HOLOTYPE: BUF); St. Joseph Peninsula State Park, 30 Jan 2005, W.C. Roody, *(Both 4589)* (BUF).

COMMENTARY: The strongly bulbous to abruptly bulbous base, the prominent pseudorhiza, the fairly large spores, and the habit in coastal sand dunes are diagnostic features of *Boletus abruptibulbus* that sets it apart from other boletes. The abruptly bulbous base appears to be more common in mature specimens while the bulbous base is more prevalent in immature ones. According to Redhead & Watling (1979) "the basal sand ball consisting of both mycelial threads and sand grains" is common to many arenicolous fungi and hence not a diagnostic feature of *B. abruptibulbus*. Within *Boletus* it appears to be closest to *Boletus auriporus* Peck and *B. flaviporus* Earle with which it shares the overall color scheme, especially the shiny and somewhat viscid pileus, but the color of the hymenophore lacks the vivid golden yellow of these, the stipe lacks the viscidity and fine yellow floccosity found in both *B. auriporus* and *B. flaviporus*. In addition the spores of *B. abruptibulbus* are longer (13.5–19.8–22.5 µm) than either of those of *B. auriporus* (11–16.05 µm: Both 1998, type study) or *B. flaviporus* (11–15: Thiers 1975). Bessette et al. (2007) published an abbreviated

macromorphological description (pp. 208-209) and a color photograph (p. 49) as *Boletus abruptibulbus* W.C. Roody and Both [nom. inval.].

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MYCOTAXON

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Two new taxa of *Bolbitiaceae* (*Agaricales*) from Croatia

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Abstract — A new species *Conocybe caeruleobasis* and a new variety *Pholiotina mairei* var. *stercorea* are described from Croatia. The descriptions are accompanied by black and white photographs of fresh basidiocarps and microscopic elements. The new taxa are compared with closely related taxa.

Key words — *Basidiomycota*, biodiversity, mycobiota, taxonomy

Introduction

The mycobiota of Croatia is poorly known due to the small number of mycologists who have researched the region. Some areas have never been mycologically explored. The first two authors of this paper made a survey of all species of the order *Agaricales* sensu lato recorded for Croatia until 2000 (Mešić & Tkalčec 2002, 2003; Tkalčec & Mešić 2002, 2003a,b). Only 11 species from family *Bolbitiaceae* were recorded (5 species of *Agrocybe,* 2 species of *Bolbitius,* 3 species of *Conocybe,* and 1 species of *Pholiotina*). In 1999, more intensive research started through the "Recording and Mapping of Croatian Fungi" project of Croatian Mycological Society. Thereafter, more than 40 species of *Bolbitiaceae* new to Croatian mycobiota have been found, as well as several taxa new to science. The first new species, *Conocybe thermophila* Hauskn. et al., is already published (Hausknecht et al. 2007). In the present paper we describe *Conocybe caeruleobasis* and *Pholiotina mairei* var. *stercorea* as new taxa.

Materials and methods

The description of *Conocybe caeruleobasis* is based on one collection consisting of 10 basidiocarps, whereas description of *Pholiotina mairei* var. *stercorea*

is based on one collection consisting of 6 basidiocarps. Photographs of basidiocarps were taken in the field. Descriptions of macroscopic characters were based on observations of fresh basidiocarps. Basidiocarps were preserved by drying. Microscopic features were observed by a light microscope (brightfield) with magnification up to 1500× and photographed with a digital camera. Descriptions and photographs of microscopic characters were made from rehydrated dried specimens mounted in 5% potassium hydroxide (KOH) solution. Some hyaline elements are observed and photographed in Congo red (1% water solution) after pretreatment in 5% KOH. Spore color was also observed in water. Ammoniacal reaction was tested according to Hausknecht (1999). Spore measurements were made from the mounts of lamellae and based on calibrated digital photographs. Only mature spores were measured (chosen on the basis of their color and appearance). For each taxon, two mature basidiocarps were chosen and 100 randomly selected spores were measured (50 from each basidiocarp). Spore measurements (length, width) are given as: (min.) stat. min. – *av.* – stat. max. (max), where "min." = minimum (lowest measured value), "stat. min." = statistical minimum (arithmetic average minus two times standard deviation), "*av.*" = arithmetic average, "stat. max." = statistical maximum (arithmetic average plus two times standard deviation), "max." = maximum (highest measured value). Standard deviation (SD) of spore length and width is also given. The length/width ratio of spores is given as the "Q" value (min. – *av.* – max.). Holotypes and accompanied data are deposited at the Croatian National Fungarium in Zagreb (CNF), while isotypes are deposited at the Herbarium of University of Vienna (WU). Comparison of *Conocybe caeruleobasis* and *Pholiotina mairei* var. *stercorea* with similar taxa is based on descriptions in the following literature: Arnolds 2005a,b, Hausknecht 1996, 2001, 2002; Hausknecht & Enderle 1992, Hausknecht et al. 2004, Kühner 1935, Ortega et al. 2000, Orton 1960, Prydiuk 2006, Singer 1968, 1989; Watling 1982, 1983.

Taxonomy

Conocybe caeruleobasis Tkalčec, Mešić & Hauskn., **sp. nov.** FIGS. 1, 3–9

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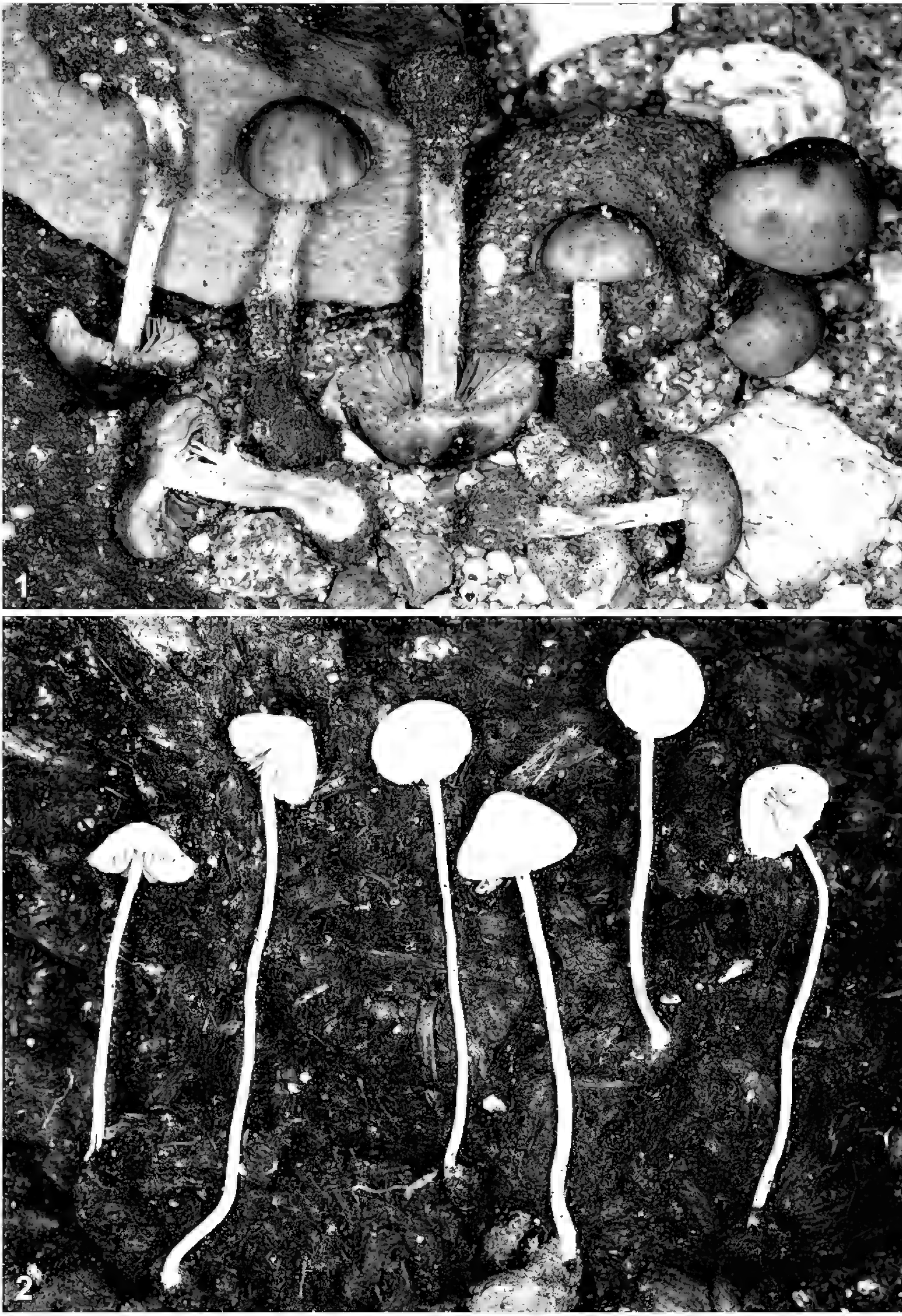
Pileus 8–14 mm latus, hemisphaericus vel convexus, tenuiter hygrophanus, humidus rubello-brunneus, siccus dilute brunneus vel ochraceus, non vel ad marginem tantum translucido-striatus, glaber. Lamellae anguste adnatae vel adnexae, primum ochraceae, demum ferrugineo-ochraceae. Stipes 12–24 × 1.8–2.5 mm, subcylindricus, basi sensim dilatatus vel bulbiformis, 1/4 ad 1/2 partis inferioris in arenam demersa, albicans vel dilute luteolo-brunneus, striatus, flocculosus. Contextus pallide vel obscure brunneus, basi stipitis pallide caeruleus. Sporae (7.0–)7.2–8.3–9.4(–9.7) × (4.8–)4.8–5.3–5.7(–5.9) µm, Q = 1.40–1.58–1.80, ellipsoideae, subamygdaliformes vel amygdaliformes, non lentiformes,



Figs. 1–2. Basidiocarps in situ. **1.** *Conocybe caeruleobasis.* **2.** *Pholiotina mairei* var. *stercorea.*

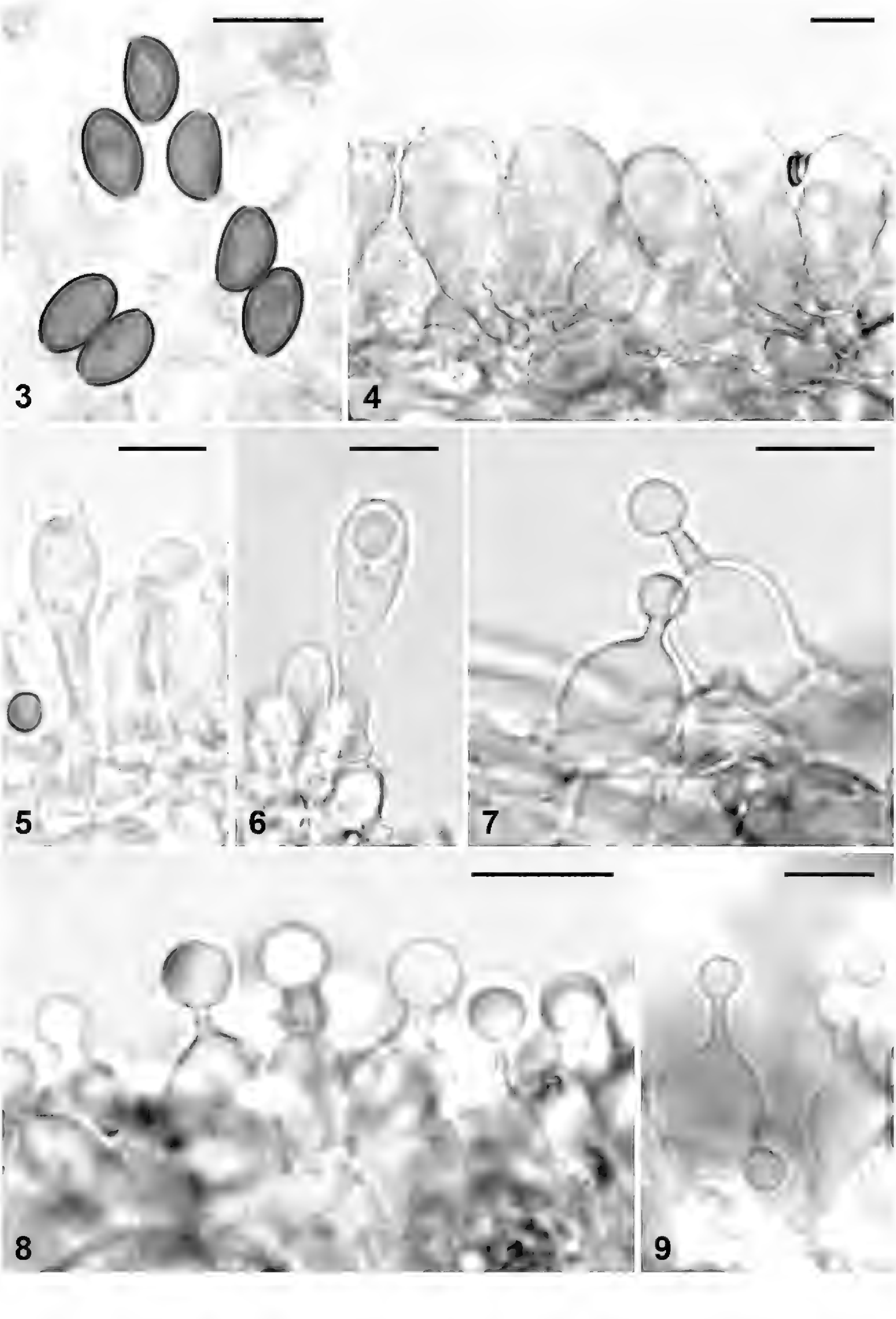
laeves, porus germinativus centralis (0.8–1.4 μm latus), in KOH ferrugineo-brunneus. Basidia 27–51 × 5–9 μm, tetrasporigera, claviformia. Cheilocystidia lecythiformia, 19–29 × 6–10 μm, capitulo (2–)3–5(–5.8) μm lato. Pileipellis hymeniformis, elementis plerumque claviformibus. Pileocystidia desunt vel rara, cheilocystidiis similia. Stipitipellis est cutis. Caulocystidia lecythiformia, 15–33 × 8–16 μm, capitulo 3.5–8 μm lato. Fibulae adsunt.

Holotype: CROATIA, Dalmatia, island of Brač, near village of Postira, 43°22'08"N, 16°40'01"E, alt. 5 m, on sandy soil mixed with gravel, 6 Dec. 2002, leg. Z. Tkalčec and A. Mešić, CNF 1/2927. Isotype: WU 28460.

Etymology: *caeruleus* (Latin) = blue, *basis* (Latin) = base; named for its blue context in the base of stipe.

Pileus 8–14 mm broad, hemispherical to convex (sometimes with slightly depressed center), rarely ± conical, moderately hygrophanous, reddish brown when moist, light brown to ochre brown on drying, not translucently striate or translucently striate at margin only, surface dull, glabrous, dry. Lamellae narrowly adnate to adnexed, moderately distant, ochre brown at first, then with rusty shade, with slightly paler to concolorous, ± even edge. Stipe 12–24 × 1.8–2.5 mm, subcylindrical with slightly swollen to bulbous base (up to 4 mm broad), its lower 1/4 to 1/2 part buried in the sand, seemingly more strongly bulbous as a result of adhering sand, whitish to light yellowish brown, fistulose, striate lengthwise, flocculose (especially in upper part), dry. Veil absent. Context light brown in stipe (except in base) and rather dark brown in pileus when moist, pale brown on drying, in the base of stipe always pale blue. Smell weak, not distinctive. Taste not recorded.

Spores (7.0–)7.2–*8.3*–9.4(–9.7) × (4.8–)4.8–*5.3*–5.7(–5.9) μm, SD = 0.55 × 0.23, Q = 1.40–*1.58*–1.80 (n = 100 spores), ellipsoid in frontal view, subamygdaliform to amygdaliform (rarely ellipsoid) in side view, not flattened, smooth, slightly thick-walled (0.5–0.7 μm), with distinct and central germ-pore (0.8–1.4 μm), rusty brown in KOH, yellow brown in H_2O. Basidia 16–39 × 7–11.5 μm, 4-spored, clavate. Lamellar edge sterile to almost sterile. Cheilocystidia 19–29 × 6–10 μm, lecythiform with globose, ellipsoid or clavate basal part, short to rather long neck and (2–)3–5(–5.8) μm broad globose capitulum, thin-walled, hyaline. Pleurocystidia absent. Pileipellis a hymeniderm made of clavate to broadly clavate, less often sphaeropedunculate, subglobose, utriform or subcylindrical elements, 21–55 × 7–28 μm, pale yellow brown to almost hyaline, pigment parietal (rarely minutely incrusting). Cells in subpellis and pileal trama yellow brown to rusty brown and pigment coarsely incrusting. Pileocystidia absent to rare, similar to cheilocystidia. Stipitipellis a cutis, made of 1.5–15 μm wide, pale yellow brown to almost hyaline hyphae with incrusting pigment. Caulocystidia similar to cheilocystidia but often somewhat larger, 15–33 × 8–16 μm, with 3.5–8 μm broad capitulum, abundant in upper part, less frequent in lower part (along with some short clavate or



Figs. 3–9. *Conocybe caeruleobasis.* **3.** Spores. **4.** Pileipellis. **5, 6.** Basidia. **7.** Caulocystidia. **8, 9.** Cheilocystidia. Bars = 10 µm.

lageniform elements). Clamp connections present. Chemical reactions: ammoniacal reaction negative.

Habitat – Open sandy sea coast with a few trees of *Cupressus sempervirens*, on sandy soil mixed with gravel.

Distribution – Croatia, known only from the type locality.

Notes: On the basis of smooth spores, almost exclusively lecythiform caulocystidia and stipe deeply buried in the sand, *Conocybe caeruleobasis* belongs to the section *Conocybe*, series *Dunensis* Hauskn. & Krisai. It is characterized by sandy habitat, stipe deeply buried in the sand, blue color in the context of stipe base, not or hardly translucently striate pileus, medium sized and not flattened spores, cheilocystidia with a rather small capitulum and negative ammoniacal reaction. Hausknecht & Krisai-Greilhuber (2006) classified three species in the series *Dunensis*. The European species *Conocybe dunensis* T.J. Wallace differs by absence of blue color in the context of stipe base, longer stipe without bulbous base, rather slender habit and much larger spores ([9.5–]10.5–14.0[–15.0] × [5.5–]6.0–8.5[–9.0] µm). The European species *C. sabulicola* Hauskn. & Enderle differs by absence of blue color in the context of stipe base, darker pileus, somewhat larger spores ([7.0–]9.0–11.0[–12.4] × [5.0–] 5.5–6.5[–6.7] µm), presence of non-lecythiform elements on the top of the stipe and positive ammoniacal reaction. The South American species *C. macrorhiza* (Speg.) Singer differs mainly by larger spores (10.5–)10.8–12.3(–14.2) × (5.3–) 6.0–7.0(–8.0) µm, absence of blue color in the context of stipe base and positive ammoniacal reaction. Singer (1968) placed *C. macrorhiza* in section *Mixtae* based on its possession of numerous non-lecythiform caulocystidia. However, the third author of this article, who studied the type material (preserved in a very bad condition) and two additional Singer collections from similar habitats in Argentina (herbarium BAFC, S502 and S536), found nearly exclusively lecythiform caulocystidia in Singer's collections. Consequently, Hausknecht & Krisai-Greilhuber (2006) placed *C. macrorhiza* in section *Conocybe*, series *Dunensis*, close to *C. sabulicola* with similar stipitipellis.

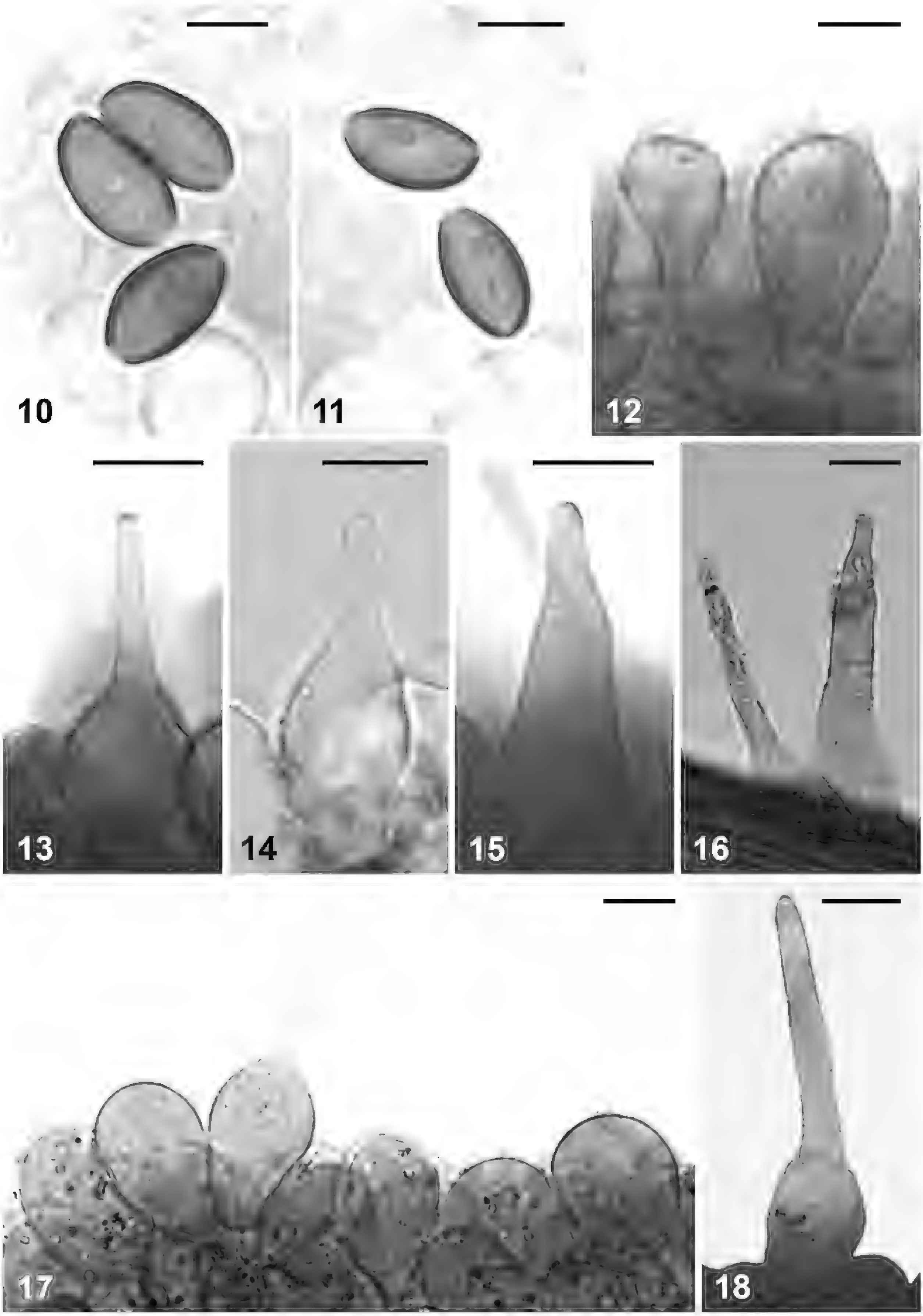
Pholiotina mairei var. ***stercorea*** Tkalčec, Mešić & Hauskn., **var. nov.** Figs. 2, 10–18
MycoBank MB 511692

A varietate typica cheilocystidiis latioribus, sporis paulum maioribus et in stercoribus crescendo differt.

Holotype: CROATIA, Žumberak mountain, near Kostanjevec Podvrški village, 45°49'50"N, 15°35'17"E, alt. 240 m, 14 Oct. 2006, leg. M. Čerkez, CNF 1/4148.

Etymology: Named for its growing on dung.

Pileus 4–5 mm broad, obtusely conical to conico-convex, hygrophanous, pale to light brown when moist, pale ochraceous to cream on drying, translucently



Figs. 10–18. *Pholiotina mairei* var. *stercorea.* **10, 11.** Spores. **12.** Basidia. **13–15.** Cheilocystidia. **16.** Caulocystidia. **17.** Pileipellis. **18.** Pileocystidium. Bars: 10–12 = 5 µm, 13–18 = 10 µm.

striate when moist, surface minutely pubescent to pruinose under a hand-lens, dry. LAMELLAE adnexed, broad, ventricose, moderately distant to distant, pale brown to ochraceous with rusty brown tinge at maturity, edge white, flocculose. STIPE 15–24 × 0.4–0.6 mm, cylindrical or slightly swollen at base, whitish to pale brown, entirely minutely pubescent under a hand-lens, dry. VEIL absent. CONTEXT concolorous. SMELL AND TASTE not recorded.

SPORES (7.6–)7.6–*8.6*–9.5(–10.1) × (4.3–) 4.4–*4.7*–5.1(–5.3) µm, SD = 0.47 × 0.16, Q = 1.62–*1.80*–2.06 (n = 100 spores), ellipsoid in frontal view, ellipsoid to amygdaliform in side view, not flattened, smooth, thin- to slightly thick-walled (0.4–0.6 µm), with distinct, central to slightly eccentric germ-pore (0.7–1.3 µm), light rusty brown in KOH, pale yellow brown in H_2O. BASIDIA 13–23(–29) × 7–9(–10) µm, 4-spored, clavate. LAMELLAR EDGE sterile. CHEILOCYSTIDIA 20–45(–56) × (5–)7–14(–17) µm, mostly lageniform with long or less frequently short, mostly thin neck, 1.5–3.5 µm broad at apex, but also conical or fusiform, thin-walled, hyaline, intermixed with some clavate, sphaeropedunculate, subglobose or ellipsoid elements. PLEUROCYSTIDIA absent. PILEIPELLIS a hymeniderm made of broadly clavate, sphaeropedunculate, ellipsoid to subglobose elements, 12–30 × 8–21 µm, hyaline. PILEOCYSTIDIA 28–60 × 8.5–20 µm, lageniform, hyaline, thin-walled, abundant. STIPITIPELLIS a cutis, made of 1.5–10 µm wide, hyaline hyphae. CAULOCYSTIDIA 21–80 × 5–15 µm, narrowly lageniform to conical, hyaline, present in the whole length of stipe, abundant (especially in upper part). CLAMP CONNECTIONS absent.

HABITAT – Alongside the stable, on heap of horse dung.

KNOWN DISTRIBUTION – Croatia, known only from the type locality.

NOTES: *Pholiotina mairei* var. *stercorea* differs from the typical variety, *P. mairei* (Watling) Enderle var. *mairei,* by growing on dung (typical variety grows on soil in deciduous forests, parks and gardens), broader cheilocystidia (5–8 µm broad in the typical variety) and slightly larger spores (6.0–8.5[–9.5] × 3.5–4.5 [–5.5] µm, average 6.7–7.8 × 3.6–4.3 µm, in the typical variety). The most similar species are *P. parvula* (Døssing & Watling) Bon, which is differentiated by longer (46–66 × 9–11 µm) cheilocystidia, smaller (6.0–7.3 × 3.8–4 µm) spores and growth on soil; *P. filipes* (G.F. Atk.) Singer (= *P. aberrans* (Kühner) Singer, = *P. sulcatipes* (Peck) Bon ss. Hausknecht 2005), which is differentiated by presence of clamp connections, somewhat longer (up to 60[–75] µm) and often subcylindrical cheilocystidia, slightly larger (7.5–11 × 4.5–6 µm) spores and growth on soil; and *P. maireiaffinis* Singer, which is differentiated mainly by presence of clamp connections, narrower (5.5–8.5 µm diam) cheilocystidia that are variably shaped (cylindrical to slightly lageniform with broader apex), somewhat smaller (6.5–8.3 × 4–5 µm) spores, and growth on soil in deciduous forests.

Acknowledgements

We are grateful to Milan Čerkez for the finding of *Pholiotina mairei* var. *stercorea*, to Ivan Šugar for his help with the Latin diagnoses, and to Gabriel Moreno (Alcalá de Henares, Spain) and Jan Vesterholt (Randers, Denmark) for their critical reviews of the manuscript.

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Lophodermium puerense sp. nov. on needles of *Pinus yunnanensis* var. *tenuifolia* from southwest Yunnan

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Abstract — A new species, *Lophodermium puerense* on *Pinus yunnanensis* var. *tenuifolia* from Puer, southwest Yunnan is described. It is similar to *L. orientale* and *L. pini-pumilae* but differs by the shape of the ascomata, presence of lip cells, the incomplete hypodermal cells present in the covering stroma, and the host relationship.

Key words — endophyte, pine, *Rhytismatales*, taxonomy

Introduction

Species of *Lophodermium* Chevall. on needles of *Pinus* spp. are endophytic and some cause serous needle cast on *Pinus*, such as *L. seditiosum* Minter et al., and *L. confluens* Y.R. Lin et al. (Ganley et al. 2004, Lin et al. 1995, Minter 1981, Minter et al. 1978). The taxonomy of *Lophodermium* on needles of *Pinus* spp. has received much attention, especially after Minter's monographic work. (He et al. 1986, Hou et al. 1996, Hou & Piepenbring 2006, Lin & Tang 1988, Lin et al. 1993, Sokolski et al. 2004). In this paper, we describe a new species of *Lophodermium* on *Pinus yunnanensis* var. *tenuifolia* W.C. Cheng & Y.W. Law from Puer, Yunnan.

Materials and methods

Sections of different thickness of ascomata were made by hand using a razor blade. Microscopic preparations were made in water, Melzer's reagent, 5% KOH, or 0.1% (w/v) cotton blue in lactic acid. For observation of ascomatal outlines in vertical section, sections were mounted in lactic acid or cotton blue

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with pretreatment in water. Gelatinous sheaths surrounding ascospores and paraphyses were observed in water or cotton blue. Ascospore contents were drawn based on observations in water mounts. Measurements were made from 20 ascospores and asci for each specimen using material mounted in 5% KOH.

Taxonomy

Lophodermium puerense C.L. Hou & M. Piepenbr., **sp. nov.** FIGURES 1–5

MYCOBANK 512113

Ascomata 350–600 µm, orbicularia, subepidermalia; paraphyses filiformes; asci 70–115 × 10–14 µm, cylindrici; ascosporae 60–90 × 1–1.5 µm, cylindricae, filiformes.

ETYMOLOGY: *puerense*, referring to the city of Puer, close to where the fungus has been found.

HOLOTYPE. On needles of *Pinus yunnanensis* var. *tenuifolia* (*Pinaceae*), Puer, Yunnan, CHINA, alt. ca. 1700 m, 11 August. 2001, C. L. Hou, R. Kirschner and M. Piepenbring 204 (AAUF).

ASCOMATA mostly on the abaxial side of secondary needles. In surface view ascomata 350–600 µm, more or less orbicular, grey to dark grey, strongly raising above the surface of the substrate, opening by a single longitudinal split. Lips present, hyaline, often invisible from the surface, split extending along about 3/4 of the entire length of the ascomata, perimeter line inconspicuous. In median vertical section ascomata subepidermal, 170–210 µm deep, covering stroma up to 30–50 µm thick near the centre of the ascomata, thinner towards the edges and only extending along half to 2/3 the covering stroma, consisting of thick-walled textura angularis with cells of 3–5 µm diam., the first layer of hypodermal cells usually degraded, 2–4 incomplete hypodermal cells still present in the covering stroma. Lip cells hyaline, 10–25 × 3–4 µm, mostly with one septum. BASAL STROMA flat, poorly developed, invisible, with some brown hyphae invading into degraded host cells underneath the subhymenium. SUBHYMENIUM 8-10 µm thick, hyaline, composed of 2–3 layers of small pseudoparenchymatous cells. PARAPHYSES 100–125 × 1–1.5 µm, filiform, not branched, septate, swollen at the apex. ASCI ripening sequentially, 70–115 × 10–14 µm, cylindrical-clavate, short stalked, thin-walled, J–, acute at the apex, without circumapical thickening, 8-spored. ASCOSPORES fasciculate, 60–90 × 1–1.5 µm, hyaline, aseptate, with a 2–3 µm thick gelatinous sheath.

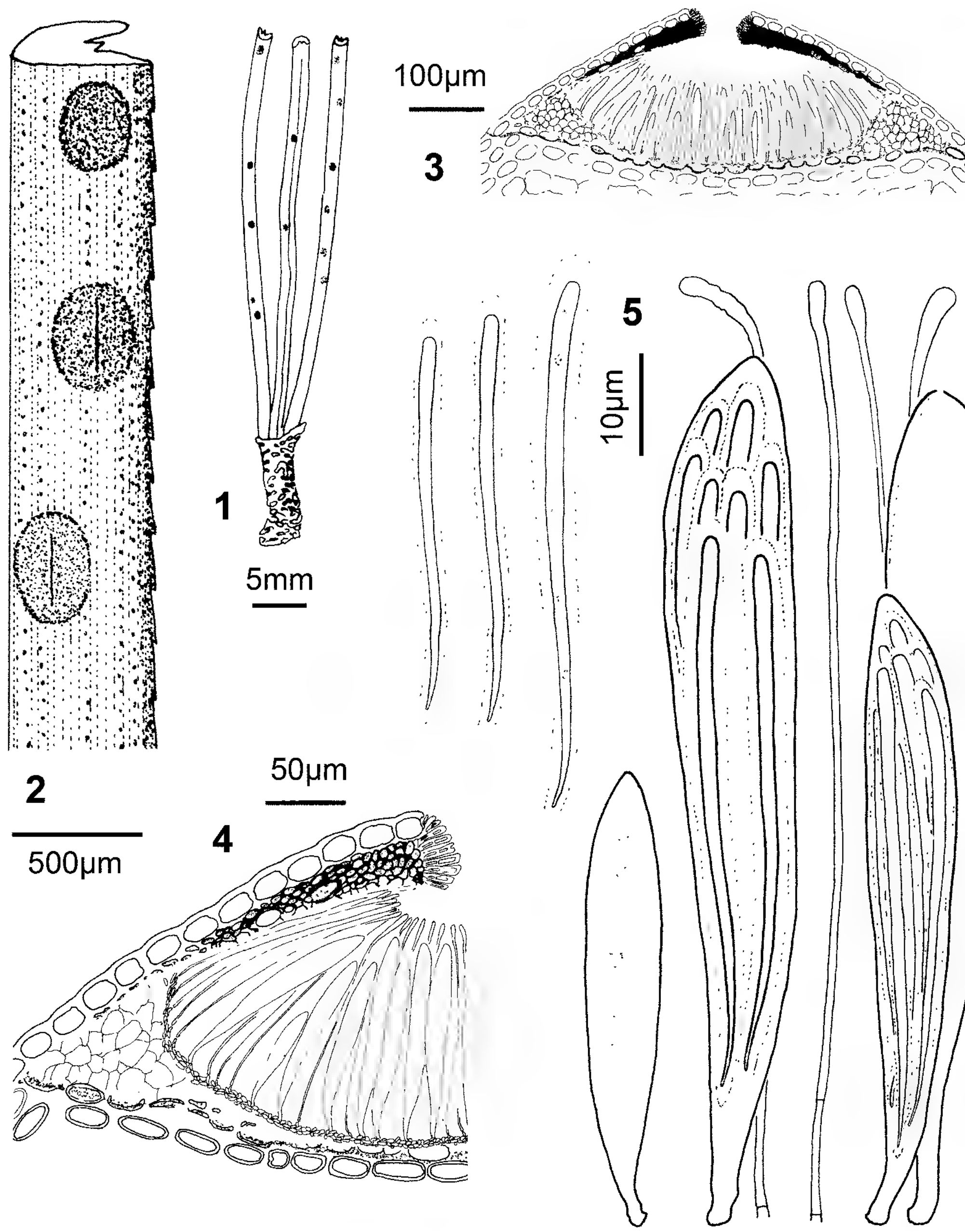
CONIDIOMATA not seen.

ZONE LINES not observed.

HABITAT: On needles that are still attached to twigs or fallen in litter.

DISTRIBUTION: *L. puerense* is known only from the type collection.

NOTES: By its subepidermal ascomata, *Lophodermium puerense* is somewhat similar to *L. orientale* Minter and *L. pini-pumilae* Sawada on five-needle pines



Figs 1–5. *Lophodermium puerense* on Pinus *yunnanensis* var. *tenuifolia*. 1. Needles bearing ascomata. 2. Ascomata observed under the dissecting microscope. 3. Ascoma in vertical section. 4. Detailed structure of an ascoma in vertical section. 5. Paraphyses, a young ascus, an ascus after the liberation of the ascospores, two mature asci with ascospores, and discharged ascospores.

(Minter 1981). However, *L. puerense* occurs on 2–3-needle pines and has conspicuous lip cells, while *L. orientale* and *L. pini-pumilae* lack lip cells. The shapes of ascomata differ among these three species. The ascomata are almost orbicular in *L. puerense*, while they are long elongate-elliptical in *L .pini-pumilae* and have a poorly marked, irregular outline in *L. orientale*. Furthermore, in *L. puerense* 2–4 incomplete hypodermal cells are present in the covering stroma.

L. puerense often occurs together with *L. conigenum* (Brunaud) Hilitzer on the same needles.

Acknowledgements

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A new species of *Phyllachora* on *Cyperaceae*

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Abstract—*Phyllachora caricis-jaluensis* sp. nov. on *Carex jaluensis* (*Cyperaceae*) is reported. Latin diagnosis and illustration of the new species are provided. The type specimen is deposited in the Herbarium Mycologicum Universitatis Agriculturalis Boreali-Occientalis (HMUABO).

Key words—*Sordariomycetidae*, identification, taxonomy

Introduction

A new species of *Phyllachora* on leaves of *Carex jaluensis* from Zhejiang province was collected in 1980. Only four species of *Phyllachora* have been previously recognized in genus of *Carex*: *P. baldensis* Petr. (Petrak 1929: 399–400), *P. lapponica* Petr. (Petrak 1936: 448–449), *P. tirolensis* Petr. (Petrak 1947: 320–321) and *P. sphaerospora* Pat. (Patouillard 1887: 126). The new species of *Phyllachora* reported here is distinguished from four earlier named species by the ovoid to (rarely) ellipsoidal shape of its ascospores.

Phyllachora caricis-jaluensis H.J. Lu & T. Zhang, **sp. nov.** **Fig. 1**

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Maculis nullis. Stromatibus amphigensis, gregariis v. rarius discretis, irregularibus, atris, fuligineis, nitidulis, 0.1–0.5 × 0.2–1.5 mm. Peritheciis in mesophyllis, 2–4 aggregatis,

* Corresponding author

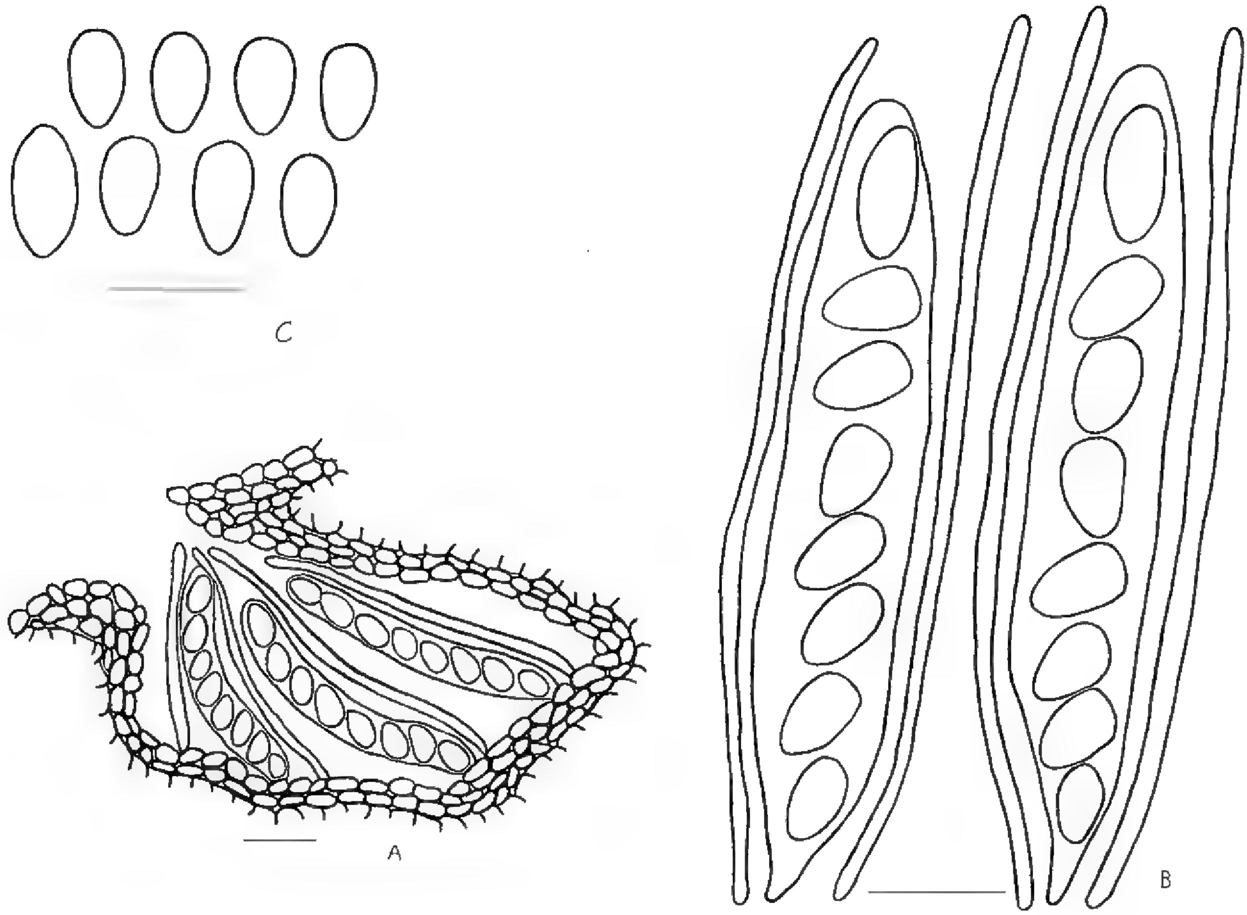

FIG.1.A: Ascoma, paraphyses, asci and ascospores of *Phyllachora caricis-jaluensis*;
B: Paraphyses, asci and ascospores of *Phyllachora caricis-jaluensis*;
C: Ascospores of *Phyllachora caricis-jaluensis*.
Scale bars: A=20µm; B, C = 10 µm.

irregularibus, pertusis, 112.2–142.8 × 71.4–122.4 µm. Paraphysibus filiformibus, aseptatis, longioribus.Ascis cylindratis, octosporatis, 51.4–76.6 × 10.3–12.9 µm, av. 61.8 × 11.7 µm, a = 8, brevitibus stipitibus, 3.9–12.3 ×3.9–4.6 µm . Ascosporidiis ovoideis vel. rarius ellipsoideis, irregalariter monostichis, unicellularibus, hyalinis, 7.7–12.9 × 4.6–7.7 µm, av. 9.9 × 5.4 µm, a = 30.

ANAMORPH: not seen.

TELEOMORPH: Parasitic on leaves of *Carex jaluensis* Kom., forming subepidermal clypeus, aggregated, rarely sparse, irregular, 0.1–0.5 × 0.2–1.5 mm, shining black, clypeus may be visible from both sides of the leaves. Ascomata immersed in the upper epidermal layer of the leaves, 2–4-loculate, irregular, the ostiole conspicuous, 112.2–142.8 × 71.4–122.4 µm. Paraphyses filamentous, aseptate, longer than asci. Asci cylindrical, 8 ascospores, 51.4–76.6 × 10.3–12.9 µm, av. 61.8 × 11.7 µm, a = 8, short pedunculate 3.9–12.3 × 3.9–4.6 µm. Ascospores ovoid, rarely ellipsoid, arranged uniseriate, one-celled, hyaline, 7.7–12.9 × 4.6–7.7 µm, av. 9.9 × 5.4 µm, a = 30.

SPECIMENS EXAMINED-On living leaves of *Carex jaluensis,* Tianmushan, Zhejiang, China, alt. 600m, 5 XI 1980, J. Y. Li & T. Y. Zhang, No. 44252, HMUABO 44544 (Holotype).

Discussion

The ovoid ascospore shape differentiates *Phyllachora caricis-jaluensis* from *P. baldensis* and *P. tirolensis*, which are diagnosed by fusiform ascospores. The ovoid shape and smaller sized spores separate the new species from *P. lapponica*, which is characterized by large (18–25 × 7–9 µm), oblong ascospores. *P. caricis-jaluensis* differs from *P. sphaerospora* in having ovoid ascospores, while the latter has spherical ascospores. Comparison of the new species with the four other *Carex*-associated species is provided in TABLE 1.

TABLE 1. Comparative morphology of *Phyllachora* species on *Carex*

Phyllachora species	HOST	ASCI (µm)	ASCOSPORES (µm)	REFERENCE
P. baldensis	*Carex baldensis*	70–80 × 10–12 —	12–20 × 3.5–5 fusiform	Petrak 1929
P. lapponica	*Carex panicea*	75–90 × 12–17 clavate or fusiform	18–25 × 7–9 oblong or ellipsoidal	Petrak 1936
P. tirolensis	*Carex firma*	45–60 × 9–11 clavate	15–20 × 3.5–5 fusiform or oval-oblong	Petrak 1947
P. sphaerospora	*Carex* sp.	80–100 × 15 cylindrical	10 spherical	Petrak 1936
P. caricis-jaluensis	*Carex jaluensis*	51.4–76.6 × 10.3–12.9 cylindrical	7.7–12.9 × 4.6–7.7 ovoid rarely ellipsoidal	this paper

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Notes on *Hymenoscyphus* — 3: On the nomenclature of *Hymenoscyphus subcarneus* (*Ascomycota, Helotiales*)

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Abstract — Since 1964 the name of the bryopathogenic species *Hymenoscyphus subcarneus* (Cooke & Peck) Kuntze has been in current use, despite being illegitimate because of homonymy. Now there is no longer need to correct this name, because in 2006 the species was transferred to a new genus, *Roseodiscus*. Up to 1964 the species was classified in *Helotium* and correctly called *H. destructor*, a name erroneously ascribed to Peck. The older homonym *Hymenoscyphus subcarneus* (Schumach.) J. Schröt. seems to be incorrect as well. It was based on *Peziza subcarnea* Schumach., which was presented by Fries as a likely synonym of *Peziza carnea* Fr. As there is sufficient evidence to support this synonymy, the new combination *Phaeohelotium carneum* is proposed. Simultaneously some related species of the '*epiphyllus* group' of *Hymenoscyphus* are transferred to *Phaeohelotium*. A concluding review of earlier and later homonyms of *Peziza carnea* Fr. reveals the incorrectness of the author citations in the current names *Geopyxis carnea* and *Ombrophila lilacina* var. *carnea*.

Key words — *Helotiaceae*, new combinations

Introduction

The name *Hymenoscyphus subcarneus* has been given to two different species of *Helotiaceae*: firstly in 1893 by Schröter (1893: 69, as '*Hymenoscypha subcarnea*') to a lignicolous species, secondly in 1898 by Kuntze (1898: 486) to a muscicolous one. However, instead of a simple case of homonymy wherein the older homonym has priority and the later one has to be rejected, the nomenclature of *Hymenoscyphus subcarneus* is more complicated. This article will clarify this matter.

Materials and methods

For this study I made use of literature from the library of the Nationaal Herbarium Nederland and – concerning Cooke (1875) – from the library of the

Hollandsche Maatschappij der Wetenschappen (deposited in Leiden University Library), both at Leiden.

All literature mentioned has been consulted in the original, except Gmelin (1792) and Langlois (1887). References to these authors have been taken from a card-index concerning *Peziza* composed by the late Dr. R.A. Maas Geesteranus.

Results and discussion

Hymenoscyphus subcarneus (Cooke & Peck) Kuntze

Hymenoscyphus subcarneus (Cooke & Peck) Kuntze 1898 is a minute, muscicolous species, growing on and apparently killing foliaceous liverworts like *Jungermannia* sp. and mosses like *Dicranum flagellare*. Hitherto it has been collected in North America (Eastern USA, Canada) and Europe (Austria, Slovakia, Switzerland, Poland). Originally it was published in March 1875 as *Peziza subcarnea* Cooke & Peck (Cooke 1875: 295). The species was also described later the same year by Peck (1875: 107). The name *Peziza subcarnea* Cooke & Peck, however, is a later homonym of *Peziza subcarnea* Schumach. 1803, and therefore illegitimate. The oldest recombination of the epithet *subcarnea* Cooke & Peck has been made by Saccardo (1889: 265), who transferred the species to the genus *Phialea* (Pers.: Fr.) Gillet. According to Art. 58 of the International Code of Botanical Nomenclature (McNeill et al. 2006) this recombination must be treated as a new name, reading *Phialea subcarnea* Sacc. Because Kuntze (1898: 486) transferred the species to *Hymenoscyphus*, it should be cited as *Hymenoscyphus subcarneus* (Sacc.) Kuntze. This name, however, is illegitimate because of its homonymy with *Hymenoscyphus subcarneus* (Schumach.) J. Schröt. 1893 (published as '*Hymenoscypha subcarnea*'). Indeed, Baral & Krieglsteiner (2006: 12) incorrectly cited the year of publication of Kuntze's Revisio generum plantarum, pars 3 ('2'), as '1889', apparently following White (1942: 163), who also listed Kuntze's book with the incorrect date. On account of this error they point out on page 14, that Schröter (1893) transferred *P. subcarnea* Schumach. to *Hymenoscyphus* 'four years after O. Kuntze transferred *Peziza subcarnea* Cooke & Peck to that genus'. Had that been the case, *H. subcarneus* (Sacc.) Kuntze would not have been illegitimate.

When White transferred the species to the genus *Helotium* Pers., he also had to deal with the problem of homonymy because the combination *Helotium subcarneum* (Schumach.) Sacc. 1881 already existed. Hence he introduced the name *Helotium destructor* 'Peck' as an avowed substitute (White 1942: 163). White appeared to ascribe this nomen novum to Peck. Consequently it was cited as '*Helotium destructor* Peck ex W.L. White' in Review of Applied Mycology, Supplement 5: 57 (1942; a publication that was subsequently renamed as 'Index of Fungi'). There is, however, no evidence at all that this name or the description

had been created by Peck. Neither did White explicitly state that Peck – who had died 25 years before, in 1917 – contributed in some way to this publication. Because of this there is no reason to attribute the nomen novum to the author, in casu Peck, to whom it was seemingly ascribed (see ICBN Art. 46.2). On the contrary White (1942: 155) states that, among the species described by Peck in *Peziza*, one was transferred to *Helotium* by Saccardo, namely *Peziza albumina* Cooke & Peck, while the other two are transferred in the 'present' paper [of White], namely *Peziza subcarnea* Cooke & Peck and *Peziza planodisca* Peck & Clinton.[1] So we may assume that White's citation of Peck's surname is not meant as a reference to the author of a published or unpublished name, but merely as a reference to the original collector of the species. Such a reference, which is not a citation of the author of the name concerned, cannot form part of the full species name (cf. ICBN Art. 46.1) and can be considered an author's or editor's mistake. In my opinion, there is no real direct association between Peck and the new name or description or diagnosis of *Helotium destructor*, so in this case the term 'ascription' does not apply (see ICBN Art. 46.3). Lizoň (1992: 49) suggested, by citing '*Helotium destructor* Peck in White', that Peck himself had published the name and description in White's paper, but that suggestion is erroneous. All in all White's nomen novum for this species must be cited as *Helotium destructor* W.L. White, not as 'Peck', 'Peck ex White' or 'Peck in White'.

Since the revaluation of the generic name *Hymenoscyphus* Gray by Dennis in 1964, this species has been accepted as belonging to that genus for decades (Dennis 1964: 68, fig. 50; Carpenter 1981: 257; Lizoň 1992: 48–49). Recently Baral & Krieglsteiner (2006) studied material from Poland and Switzerland. They demonstrated that *H. subcarneus* (Cooke & Peck) Kuntze is closely related to the likewise pink-coloured *H. rhodoleucus* and *H. equisetinus*, both growing on stems of *Equisetum*. Because of the *Calycina*-type of annulus (apical ascus ring), these three species do not fit within the genus *Hymenoscyphus* so that a new genus *Roseodiscus* Baral, typified by *R. rhodoleucus*, was erected for them. As long as molecular data do not contradict this classification, it appears to be a justified position for *R. subcarneus* (Sacc.) Baral. As a consequence there is no longer a need to replace the illegitimate name *H. subcarneus* (Sacc.) Kuntze by a legitimate specific name within the genus *Hymenoscyphus*.

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[1] By White (1942: 171) erroneously mentioned as '*Helotium planodiscum* (Peck & Cooke)'. In the protologue the authors are cited as 'P. & C.' (Peck 1879: 46). In this report, however, Peck used 'C.' to indicate a number of different authors, i.a. Cooke, Curtis and Clinton. *Peziza planodisca* was collected, like all of the 'P. & C.' species described in this report, by G.W. Clinton. This indicates that 'P. & C.' stands for Peck & Clinton. Besides, Cooke was the senior author of discomycete names published while Peck was consulting with him a few years earlier, so it is very improbable that Peck in subsequent years would include Cooke as a junior author.

***Hymenoscyphus subcarneus* (Schumach.) J. Schröt.**

Hymenoscyphus subcarneus (Schumach.) J. Schröt. 1893 is a saprotrophic species growing mainly on decorticated wood or chips of deciduous trees. It has been reported from i.a. United Kingdom, Denmark, Germany, Belgium and the Netherlands. A collection from Switzerland, described and depicted by Breitenbach & Kränzlin (1981: 158–159 as *Phaeohelotium subcarneum*), seems to represent *Hymenoscyphus imberbis* (Bull. : Fr.) Dennis, because the apothecia are not equably pink-coloured but white with wine-red spots (see Baral 1986: 17).

Its name is based on *Peziza subcarnea* Schumach. 1803. Fries did not sanction this name, but added to his description of *Peziza carnea* Fr.: '*P. subcarnea* Schumach. Saell. p. 427 huc pertinere videtur' (Fries 1822: 135). In the separately published index of the same work the name *P. subcarnea* Schumach. is equally arranged and provided with a question-mark (Fries 1832: 138). So Fries considered it likely synonymous with his own *P. carnea*. In 1849 Fries transferred *P. carnea* to the genus *Helotium*, without mentioning synonyms or presenting *P. subcarnea* as a separate species (Fries 1849: 356). This may be interpreted as though he had become convinced of the synonymy of both names. One could object that Fries did not present *P. subcarnea* Schumach. unreservedly as synonymous with *P. carnea* Fr. Actually this discrepancy is of minor importance. The point is whether the two names are synonymous or not. If so, one must use the specific epithet *carnea* Fr. for the species concerned; if not, both epithets are available for the respective species.

According to the original description based on fresh specimens, *Peziza carnea* Fr. is an autumnal SPECIES with small, up to 2.5 mm ('½ to 1 line') wide, subsessile, soft-fleshed ('fleshy-waxy'), smooth, convex, flesh-coloured apothecia, occurring on dead, decorticated wood of i.a. *Fagus* and *Carpinus* (Fries 1822: 135). Fries classified it in section *Lenticulares*, together with other saprotrophic species with more of less flat to slightly convex, sessile to short-stalked apothecia, like *P. imberbis*, *P. faginea* and *P. epiphylla*. These three relatives are microscopically characterized by i.a. an outer excipulum of thin-walled textura globulosa to angularis, asci originating from croziers and ellipsoid, non-scutuloid, asetulose spores (Hengstmengel 1984). They form a rather homogeneous group, which was called stirps *Epiphylleae* (of the genus *Helotium*) by Dennis (1956: 67) and '*epiphyllus* group' (within the genus *Hymenoscyphus*) by Dumont (1981: 60). To this '*epiphyllus* group' also belongs the smooth, soft-fleshed, pale purplish-pink, lignicolous *Hymenoscyphus subcarneus* (Schumach.) J. Schröt., not only because of its similarity in morphological and anatomical characters, but also because of the resemblance

in ultrastructure of the ascus apical apparatus between the latter and *H. imberbis*, as was demonstrated by Verkley (1993). Actually *H. subcarneus*, originally collected on rotten wood of *Betula alba* in Saelland (Denmark), cannot be distinguished from *Peziza carnea* Fr. as macroscopically described by Fries (1822: 135). For this reason I judge these two species synonymous, also supported by Fries's opinion about their resemblance. Unfortunately there is no type material preserved for microscopical comparison.

Likewise Saccardo (1889: 240), Rehm (1892: 657) as well as Schröter (1893: 69) considered *P. carnea* Fr. synonymous with *P. subcarnea* Schumach. They used for this taxon the non-sanctioned epithet *subcarnea* Schumach., combined with the generic names *Pezizella* and *Hymenoscypha* respectively. This was presumably correct at that time, for previous to the introduction of the 1821 starting point for 'Fungi caeteri', *P. carnea* Fr. was considered unavailable as being a later synonym, besides being a later homonym. However, *P. carnea* Fr. became the earliest available name under the 1821 starting point, and continues to have priority as a sanctioned name (Art. 15.1) under the 1753 starting point of the current ICBN.

H. subcarneus (Schumach.) J. Schröt. is currently placed in the genus *Phaeohelotium* Kanouse (Dennis 1981: 130–131, pl. XXIX K; Hansen & Knudsen 2000: 159; see also www.indexfungorum.org, record number 319579). I fully agree with that classification, because the species of this genus have similar morphological, anatomical, and ecological characters. *Ph. subcarneum* (Schumach.) Dennis does not show the light brown coloration and punctation of the wall in (over)mature spores, as known in i.a. *Ph. monticola* (Berk.) Dennis (= *Ph. flavum* Kanouse, the type species of the genus) and after which the genus *Phaeohelotium* is named. This character, however, is neither observed in some other species of *Phaeohelotium*, like *Ph. nobile* (Velen.) Dennis and *Ph. trabinellum* (P. Karst.) Dennis (Dennis 1971: 356; Hansen & Knudsen 2000: 159). Besides, the brown coloration has also been found in species outside *Phaeohelotium* and outside the '*epiphyllus* group' of *Hymenoscyphus*, e.g. in *H. salicellus* (Fr. : Fr.) Dennis (Hengstmengel 1984: 82), *H. serotinus* (Pers. : Fr.) W. Phillips (collection HMAS 96819 = HB 5830), *Rutstroemia firma* (Pers.: Fr.) P. Karst. (Galán & Baral 1997: 61) and *Lambertella torquata* W.Y. Zhuang (Zhuang 1995: 42). So this character is neither obligate nor exclusive for species of the genus *Phaeohelotium* and thus not differentiating at the generic level. Probably it is not even an essential character (Dennis 1981: 130).

Because of the nomenclatural priority of *Peziza carnea* Fr. : Fr. over its non-sanctioned synonym *P. subcarnea* Schumach., the following combination is proposed:

Phaeohelotium carneum (Fr. : Fr.) Hengstm., **comb. nov.**

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Basionym: *Peziza carnea* Fr. : Fr., Syst. mycol. 2 (1): 135 (1822), non (Hedw.) J.F. Gmel. 1792, nec Pers. 1822, nec (Pers. : Fr.) P. Karst 1869, nec Ellis & Everh. 1887 [nom. nud.], nec Cooke & W. Phillips 1887

≡ *Helotium carneum* (Fr. : Fr.) Fr., Summa veg. Scand. (2): 356 (1849)

= *Peziza subcarnea* Schumach., Enum. pl. Saell. 2: 427 (1803), non Cooke & Peck 1875

≡ *Helotium subcarneum* (Schumach.) Sacc., Michelia 2 (2): 260 (1881)

≡ *Pezizella subcarnea* (Schumach.) Rehm, Rabenh. Krypt.-Fl. ed. 2, 1 (3) (38): 657 (1892)

≡ *Hymenoscyphus subcarneus* (Schumach.) J. Schröt., Pilze Schles. 2 (1): 69 (1893) [as '*Hymenoscypha subcarnea*'], non (Sacc.) Kuntze 1898

≡ *Calycina subcarnea* (Schumach.) Kuntze, Revis. gen. pl. 3 (3): 449 (1898)

≡ *Orbiliopsis subcarnea* (Schumach.) Höhn., Mitt. Bot. Inst. T.H. Wien 3 (3): 102 (1926)

≡ *Phaeohelotium subcarneum* (Schumach.) Dennis, Kew Bull. 25 (2): 355 (1971)

The recognition of *Phaeohelotium* as a genus separate from *Hymenoscyphus* is fully justified by the obvious differences in i.a. the structure of the excipulum and the ascus apical apparatus, and is supported by molecular evidence. Recently some molecular phylogenetic investigations, based on sequence analyses of the rDNA ITS1-5.8S-ITS2 region, have been done in a number of *Helotiaceae* and other *Helotiales* (Zhang & Zhuang 2004, Baral et al. 2006, Boonyuen et al. 2006, Zhuang & Liu 2007). These studies confirm that *H. epiphyllus* is placed in a sister group (with high bootstrap support) to *Hymenoscyphus* sensu stricto (= *H. fructigenus* (Bull. : Fr.) Gray and allied species with scutuloid ascospores). Hitherto too few species of the '*epiphyllus* group' or the genus *Phaeohelotium* have been investigated molecularly to be able to say something about the size and content of this sister group.

Being *H. subcarneus* rightly classified in the genus *Phaeohelotium*, as argued above, other species of the '*epiphyllus* group' should be classified in *Phaeohelotium* as well. Up to now this is only partially the case. *Hymenoscyphus imberbis*, for instance, was already transferred to *Phaeohelotium* by Svrček (1985: 152), but *H. epiphyllus* (Pers. : Fr.) Rehm ex Kauffman with its var. *acarius* (P. Karst.) Hengstm., *H. carpinicola* (Rehm) Arendh. and *H. fagineus* (Pers. : Fr.) Dennis have not yet been transferred. Therefore the following new combinations are added:

Phaeohelotium carpinicola (Rehm) Hengstm., **comb. nov.**

MycoBank 512565

Basionym: *Helotium carpinicola* Rehm, Hedwigia Beibl. 35 (6): (146) (1896) [as '*carpinicolum*']

Phaeohelotium epiphyllum (Pers. : Fr.) Hengstm., **comb. nov.**

MycoBank 512512

Basionym: *Peziza epiphylla* Pers., Annln. Bot. (ed. Usteri) 11: 30 (1794) : Fr., Syst. mycol. 2 (1): 137 (1822); non Schumach. 1803

Phaeohelotium epiphyllum* var. *acarium (P. Karst.) Hengstm., **comb. nov.**
MycoBank 512513
Basionym: *Peziza epiphylla* var. *acaria* P. Karst., Monogr. Peziz. fenn.: 143 (1869)

Phaeohelotium fagineum (Pers. : Fr.) Hengstm., **comb. nov.**
MycoBank 512514
Basionym: *Peziza faginea* Pers., Neues Mag. Bot. 1: 114 (1794) : Fr., Syst. mycol. 2 (1): 136 (1822)

Published earlier and later homonyms of *Peziza carnea* Fr. : Fr.

The publication by Fries (1822: 135) of *Peziza carnea* Fr. : Fr. has consequences not only for the availability of synonyms but also of earlier homonyms.

Already in 1792 Gmelin published the name *Peziza carnea* (Hedw.) J.F. Gmel., being based on *Octospora carnea* Hedw. 1789 (Gmelin 1792: 1458). Although this recombination must be treated as rejected in favour of the sanctioned *P. carnea* Fr. : Fr., it is not illegitimate but unavailable for use (ICBN Art. 15.2). However, since the beginning of the nineteenth century it is considered synonymous with the current name *Ascocoryne sarcoides* (Jacq. : Fr.) J.W. Groves & D.E. Wilson; see e.g. Persoon (1801: 633), Fries (1822: 168) and Saccardo (1889: 642). Besides being sanctioned, the basionym of the latter, *Lichen sarcoides* Jacq. 1781, has priority over its heterotypic synonym *Octospora carnea* Hedw. 1789. Consequently the correct name for this species is a combination based on Jacquin's name and the name *P. carnea* (Hedw.) J.F. Gmel. can remain an unavailable heterotypic synonym.

In 1822, in the same year as (but earlier than) the publication of *Peziza carnea* Fr. : Fr., Persoon (1822: 301) published *P. carnea* Pers. The latter is not only unavailable as a name because of the status of *P. carnea* Fr. : Fr., but also illegitimate as a later homonym of *P. carnea* (Hedw.) J.F. Gmel. 1792. For this reason it may not serve as a basionym of another name or combination based on the same type (ICBN Art. 15.2). Fries, however, acknowledged Persoon's taxon and changed its rank to varietal by recombining the epithet *carnea* Pers. into '*P. lilacina* β. *P. carnea* Pers.', a name which has to be altered to *P. lilacina* var. *carnea* (ICBN Art. 24.4).[2] The resulting name is treated as new and the

[2] In the Systema mycologicum – as in several other botanical and mycological works from the nineteenth century with one or more infraspecific ranks – the infraspecific taxa marked with a Greek minuscule have the rank of variety, as Fries often explicitly mentions. See e.g. Fries (1821: 352): 'Praesens varietas ...', or Fries (1822: 129–130): 'Sequens varietas ...'. There is one exception, in which Fries refers to some infraspecific taxa marked with Greek minuscules as 'Subspecies sequentes' (Kuyper, pers. comm.), viz. in *Agaricus fibula* Bull. : Fr. (Fries 1821: 163–164). Among these 'subspecies' is '*A. fibula* γ. *Swartzii*', based on *A. swartzii* Fr. 1815. In the index of the same work Fries points out with regard to this *A. swartzii* Fr. to consider this taxon as a **variety** of *A. fibula* (Fries 1832: 44). This means that he used the term 'subspecies' not as the name of a definite rank, but to indicate taxa below species level. Therefore I see no reason to deny the general rule, that in the cited work Greek minuscules – unless otherwise stated – are used for varieties.

correct author citation of this variety is 'Fr. : Fr.', not '(Pers.) Fr.' (ICBN Art. 58). Since Saccardo (1889: 614) transferred this taxon to the genus *Ombrophila*, as '*Ombrophila lilacina* β. *O. carnea* Pers.', its correct name is ***Ombrophila lilacina* var. *carnea* (Fr. : Fr.) Sacc.**,[3] not '(Pers.) Sacc.' as is currently cited.

There exist at least three later homonyms of *P. carnea* Fr. : Fr. Their illegitimacy is, of course, in the first instance due to the existence of the earliest though unavailable one, namely *P. carnea* (Hedw.) J.F. Gmel. 1792.

In 1869 Karsten (1869: 120) created the homonymous recombination *Peziza carnea* (Pers. : Fr.) P. Karst. There is no need to rectify this name, which was based on *Ascobolus carneus* Pers. : Fr., because it is no longer current. Nowadays the species concerned is called *Iodophanus carneus* (Pers. : Fr.) Korf.

In 1887 the name *Peziza carnea* Ellis & Everh. was published in Langlois (1887: 32). Whatever this species may be, its name was accompanied neither by a description or diagnosis nor by a reference to a previously and effectively published description or diagnosis (thus being a nomen nudum) and therefore it was not validly published (ICBN Art. 32.1(d)).

About simultaneously W. Phillips published the new terrestrial species *Peziza carnea* Cooke & W. Phillips, based on a British collection of '*Peziza cupularis* L. var.' in the herbarium of M.J. Berkeley (Phillips 1887: 48). Saccardo (1889: 65) transferred the species to the genus *Geopyxis* and called it *Geopyxis carnea* 'Cooke et Phill.'. Because of the illegitimacy of the basionym, this recombination must be treated as a new name and has to be cited as ***Geopyxis carnea* Sacc.**, not '(Cooke & W. Phillips) Sacc.' (ICBN Art. 58).

[3] Also in Saccardo (1889) the infraspecific rank marked with a Greek minuscule is the varietal rank. Besides, in this work a variety can be marked by the word "Var." or by the combination of this abbreviation with a Greek minuscule, e.g. "Var. β".

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The genus *Cystolepiota* (*Agaricales, Basidiomycota*) in Kerala State, India

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Abstract — Three species of the genus *Cystolepiota* are documented from Kerala State, India including a new species, *C. furfuracea*. *Cystolepiota fumosifolia* is new to Asia and *C. pulverulenta* is new to India.

Key words — *Agaricaceae*, floristics, lepiotaceous fungi

Introduction

Cystolepiota Singer (*Agaricaceae*, *Agaricales*) is a genus closely allied with section *Echinatae* of *Lepiota* sensu stricto, distinguished from the latter in having mostly inamyloid and uninucleate spores and a pileus covering composed of more or less loosely arranged, inflated, globose, oblong or elongate elements. The pileal covering of members belonging to *Lepiota* section *Echinatae* has hyphae gradually transient into globose or ellipsoid elements (Vellinga 2001), making up the pyramidal squamules whereas such intermediate cells constituting the veil are absent in *Cystolepiota* (Knudsen 1980).

Only one species of *Cystolepiota*, *C. hemisclera* (Berk. & M.A. Curtis) Pegler, has been recorded from India so far (Vrinda et al. 1997). Our investigations on the lepiotaceous agarics of Kerala revealed a new species of *Cystolepiota* and two new records. The new species is fully described and illustrated below along with brief accounts of the two new records.

Materials and methods

Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% KOH. Pigmentation and exudates if any were noted by mounting the material in water. Melzer's reagent, cresyl blue and cotton blue were used to observe whether the spores

were dextrinoid, metachromatic, and cyanophilic respectively. In all cases, spore measurements were taken from twenty randomly selected spores. Colour codes refer to Kornerup & Wanscher (1978). The holotype of the new species and additional and/or representative collections of all taxa documented here are at Kew (K) and these collections are indicated by their Kew (Mycology) accession numbers (e.g., K(M)155998). All other collections examined are in the personal herbarium of the second author.

Taxonomic account

Key to the *Cystolepiota* species of Kerala

1a. Hymenial cystidia and clamp-connections absent; spores 4–6 × 2–3 µm
. . . . *C. pulverulenta*

1b. Hymenial cystidia and clamp-connections present 2

2a. Spores dextrinoid, 5.5–7.5 × 2.5–3.5 µm . . . .*C. hemisclera*
[reported from Kerala by Vrinda et al. (1997); not collected during our study]

2b. Spores inamyloid, 4–6 × 2–3.5 µm 3

3a. Cheilocystidia and pleurocystidia with yellowish contents and exudates; pileal covering made of subglobose to globose elements; spores 4–5 × 2–3 µm
. . . . *C. fumosifolia*

3b. Cheilocystidia without any exudates; pleurocystidia absent; pileal covering made of inflated cylindrical or ellipsoid cells; spores 4–6 × 2.5–3.5 µm
. . . . *C. furfuracea*

Description of new species

Cystolepiota furfuracea T.K.A. Kumar & Manim., **sp. nov.** FIGURE 1
MYCOBANK MB511633

Pileus 17.5–20 mm latus, e globose expansus, albus, non striatus, squamis furfuraceis pallide luteolis decoratus. Lamellae liberae, albidae, moderate confertae. Stipes 20–23 × 1–1.5 mm, ad basim inflatus, solidus, albidus, squamulosus. Sporae 4–6 × 2.5–3.5 µm, ellipsoideae, hyalinae, laeves, inamyloideae, azurei cresylici non-metachromaticae. Cheilocystidia cylindrico-clavata, clavata vel utriformia. Pleurocystidia nulla. Cuticula pilei ex hyphis et sphaerocystis composita. Hyphae omnes fibulatae.

HOLOTYPE: **INDIA, KERALA STATE, Thiruvananthapuram District,** PALODE: 18 July 2005, Arun Kumar AK355 (K(M)155998, **HOLOTYPE**).

ETYMOLOGY: *furfuracea* (L), scurfy

BASIDIOMATA small; PILEUS 17.5–20 mm diam., globose when very young, expanding to become convex and finally applanate on maturity; surface whitish with yellowish white (4A2) to pale yellowish (4A3) furfuraceous squamules that are almost spiny towards the centre, non-striate; margin initially incurved, becoming straight, entire; LAMELLAE free, whitish, moderately crowded, up to 2 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens,

concolorous with the sides; STIPE 20–23 × 1–1.5 mm, central, terete, almost equal, with a subbulbous base, solid; surface whitish, turning brownish orange (7C4) on bruising, with detersile, cottony squamules; base connected to white mycelial cords; ANNULUS not observed; CONTEXT up to 1 mm thick, whitish, turning brownish orange (7C4) on exposure; ODOUR not distinctive; SPORE-PRINT not obtained.

SPORES 4–6 × 2.5–3.5 (5 ± 0.44 × 3 ± 0.22) µm, Q = 1.3–2, Qm = 1.7, ellipsoid to oblong or subcylindrical, hyaline, with refractive guttules, slightly thick-walled, smooth, inamyloid, non-dextrinoid, non-metachromatic in cresyl blue, cyanophilic in cotton blue; BASIDIA 13–22 × 6–8 µm, clavate, with guttulate contents, hyaline, 4-spored, with sterigmata up to 3 µm long; lamella-edge sterile; CHEILOCYSTIDIA crowded, 15–55 × 5–17 µm, cylindrico-clavate, clavate, or utriform, thin-walled, hyaline, guttulate, with basal clamp-connections; PLEUROCYSTIDIA absent; LAMELLAR TRAMA subregular; hyphae 2–17 µm wide, slightly inflated, hyaline, thin-walled, inamyloid; SUBHYMENIUM cellular; PILEAL TRAMA interwoven; composed of inflated, septate, 3–17 µm wide, hyaline, thin-walled, inamyloid hyphae; PILEAL COVERING a highly disrupted cutis composed of both ascending or erect, inflated, 2–15 µm wide hyphae and loosely arranged detersile chains of cylindrical or ellipsoid, 17–42 × 4–13 µm large elements; hyphae thin-walled and with pale yellowish to brown plasmatic pigments; STIPE COVERING a disrupted cutis of loosely arranged cylindrical or ellipsoid elements similar to those of the pileal covering. All hyphae with clamp-connections.

HABITAT: On soil among decaying leaf litter, solitary.

ADDITIONAL COLLECTION EXAMINED — **INDIA, KERALA STATE, Thiruvananthapuram District,** PALODE: 20 July 2005, Arun Kumar AK370 (K(M)157120).

DISCUSSION: The outstanding characteristics of this small-sized species are the yellowish, furfuraceous squamules that become somewhat spiny towards the centre of the pileus; ellipsoid spores that are inamyloid and non-metachromatic in cresyl blue; cylindrico-clavate, clavate or utriform cheilocystidia; and a pileal covering with loosely attached chains of cylindrical or ellipsoid elements. Gross morphology of this species is reminiscent of *Lepiota cystophoroides* Joss. & Riousset, *L. scaberula* Vellinga, and *Cystolepiota cystophora* (Malençon) Bon. However, dissimilarities, especially with regard to the microscopical characteristics, exist that make *C. furfuracea* unique.

Lepiota cystophoroides [see Bon (1996) and Candusso & Lanzoni (1990) for species descriptions] differs from *Cystolepiota furfuracea* in having somewhat larger basidiomata that usually develop a vinaceous-purple tint on bruising. Although *C. furfuracea* basidiomata also change colour turning brownish orange on bruising, vinaceous-purple tinges are not observed. The spores of

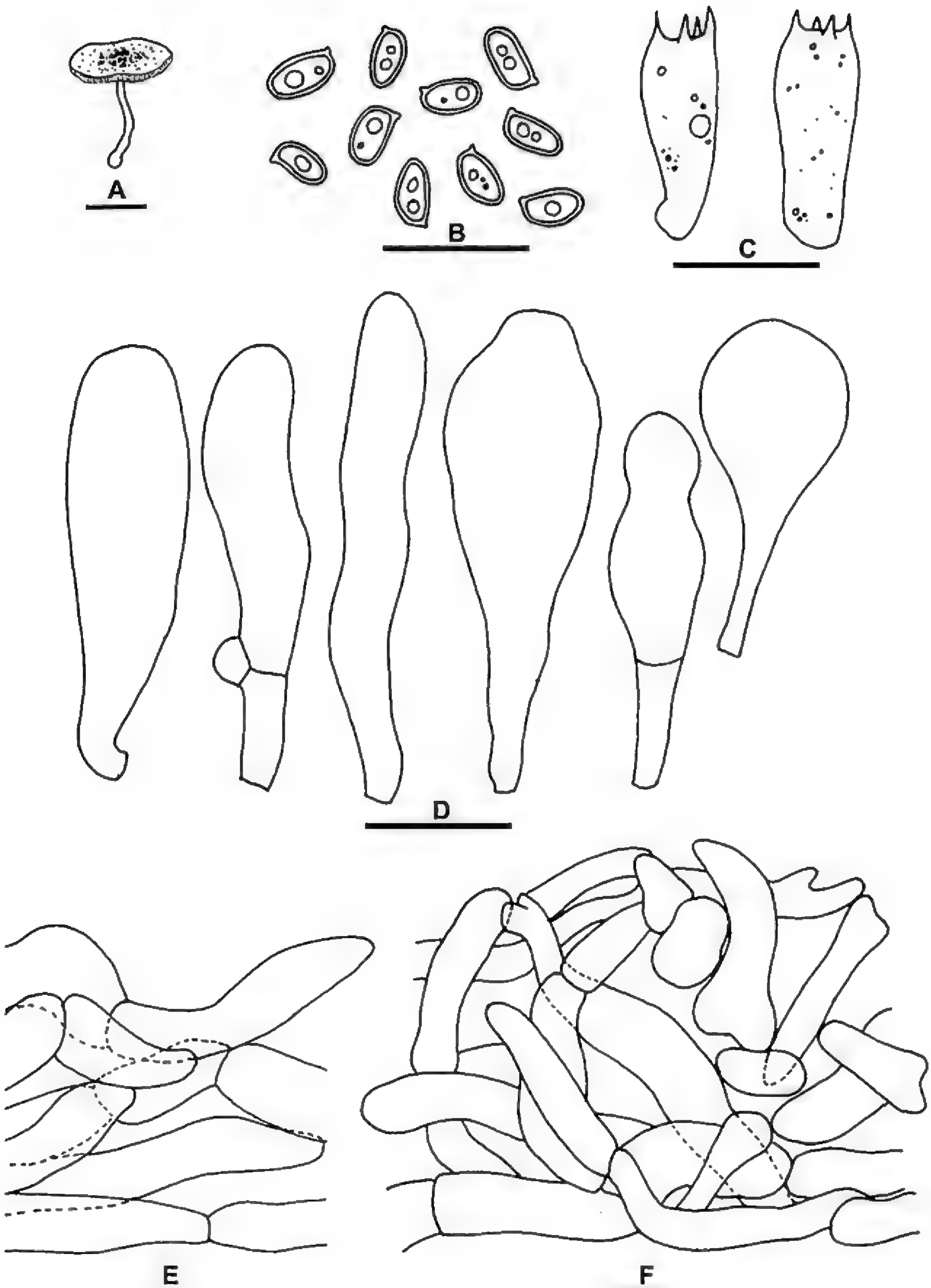

Figure 1. *Cystolepiota furfuracea*. A, habit, scale bar = 10 mm.
B, basidiospores; C, basidia; D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

L. cystophoroides are larger (6–8 × 3–4.5 µm) and somewhat dextrinoid. Spores of *C. furfuracea* are unmistakably non-dextrinoid. The squamulose pileal surface of *L. cystophoroides* is made up of erect, compactly arranged clavate elements bearing (sub)globose terminal elements. Remarkably, *C. furfuracea* lacks such a compact palisade-like arrangement with clavate elements and has a furfuraceous pileal covering composed of highly disrupted and loosely arranged chains of cylindrical or ellipsoid terminal elements, borne on inflated cylindrical hyphae. This contrasting nature of the pileal covering is the most important distinction between *L. cystophoroides* and *C. furfuracea.*

Lepiota scaberula, a species closely related to *L. cystophoroides,* could be distinguished from *Cystolepiota furfuracea* in having little scurfy scales, a distinctly glabrous patch at the centre of the pileus, a large stipe that is pale reddish towards base, larger spores (5–7 × 3–4 µm) with an inner wall pink in cresyl blue, and by the clavate terminal elements of pileal covering.

Cystolepiota cystophora has larger basidiomata with a relatively broader pileus (usually 20–40 mm) and stout stipe (usually 30–60 × 3–4 mm). A distinct rosy or pinkish brown colouration is seen towards the stipe base that is absent in *C. furfuracea*. *Cystolepiota cystophora* possess larger spores (6–8 × 4–5 µm), and the pileal covering is composed of clavate or pyriform elements with distinct sphaerocysts (Bon 1996, Candusso & Lanzoni 1990). Clavate or pyriform elements and typical sphaerocysts are absent in *C. furfuracea.*

Another species with similar size and shape of spores and a comparable pileal structure is *C. pulverulenta* that could be easily differentiated based on its dextrinoid spores (reaction usually slow and weak) and the absence of cystidia and clamp connections.

Although *Cystolepiota furfuracea* shows similarities with members of *Lepiota* section *Lilaceae* macroscopically and in a few microscopic characteristics, the non-hymenidermal pileal covering in *C. furfuracea* prevents the species from being classified there. Moreover, the unique character combinations observed in *C. furfuracea* does not seem to favour a satisfactory placement in the genus *Lepiota*. Rather, the very small basidiomata, furfuraceous covering of pileus and stipe that are easily removed on handling, and small spores that are non-dextrinoid, are suggestive of species belonging to the genus *Cystolepiota.* In addition, the arrangement of the pileal covering, with inflated and loosely attached velar elements suggests placement in *Cystolepiota.*

The original concept of *Cystolepiota* considered only species with a pileal covering composed of globose cells. However, Vellinga (1992) widened the concept by including *Lepiota pulverulenta* Huijsman, allowing room for species with inflated, non-globose velar elements in *Cystolepiota*. Accordingly, *C. furfuracea* with inflated, cylindrical or ellipsoid pileal elements also seems

relatively well-placed in the genus. In view of the above considerations, we find it more appropriate to treat *C. furfuracea* within the genus *Cystolepiota* than considering it as a *Lepiota.*

Documentation of new records

Cystolepiota fumosifolia (Murrill) Vellinga, Mycotaxon 98: 226 (2006)

Selected descriptions and figures: Vellinga (2001: 155–156, as *C. cystidiosa*), Vellinga & Huijser (1998: 518–521, as *C. cystidiosa*), Vellinga (2006: 226–228).

Pileus 7–22 mm diam.; surface yellowish white (2A2, 3A2), densely covered with detersile, granular to floccose, greyish orange (5B3) to light brown (6D7) or brown (7E5) squamules; lamellae free, yellowish white (3A2) to pastel yellow (3A4) turning dark brown (6E8) on bruising or on drying, moderately crowded to crowded, up to 4 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens, concolorous with the sides; stipe 25–43 x 1–3 mm, central, terete, almost equal or slightly tapering towards apex, fistulose; surface yellowish white (2A2), turning brown (7E5) to dark brown (6E8) on bruising, covered with grayish orange (5B3) to light brown (6D7), floccose scales below the annulus that are easily removed on handling; base arising from a white mycelium; annulus present as a thin fibrillose ring, superior, ascending, evanescent; context up to 2 mm thick, whitish; odour not distinctive; spore-print yellowish white (1A2).

Spores 4–5 x 2–3 (4 ± 0.31 × 2.3 ± 0.44) µm, Q = 1.3–2.25, Qm = 1.9, ellipsoid to subcylindric, hyaline, with oil guttules, smooth, thin- to slightly thick-walled, inamyloid, non-dextrinoid, non-metachromatic in cresyl blue, cyanophilic in cotton blue; basidia 12–20 × 5–7 µm, cylindrico-clavate to clavate, sometimes slightly flexuose, with minute guttulate contents and yellowish exudates, bearing 4 sterigmata up to 4 µm long; cheilocystidia abundant, 20–45 x 6–15 µm, versiform: fusiform, clavate, ventricose-rostrate, obovoid, or utriform; many with subcapitate or slightly protruding apices, hyaline to pale yellow, thin- to slightly thick-walled (up to 0.5 µm), sometimes with yellowish exudates on the surface, strongly dextrinoid; pleurocystidia 35–53 x 8–18 µm, abundant, evenly dispersed on the sides of lamellae, fusiform, broadly fusiform, ventricose-rostrate, or obclavate, hyaline to pale yellow, thin-walled, dextrinoid, with yellowish exudates on the surface; pileal covering composed of subglobose to globose cells (sphaerocysts), 17–80 µm in diameter, interspersed with 2–7 µm wide, thin- to slightly thick-walled hyphae with pale yellowish to light brown plasmatic and membrane pigments. All hyphae with clamp-connections.

Habitat: On soil and decaying leaf litter, solitary or gregarious.

Collections examined — **INDIA, Kerala State, Thiruvananthapuram District,** PALODE: 2 August 2006, Arun Kumar AK421; 3 August 2006, Arun Kumar AK421a;

4 August 2006, Arun Kumar AK435 (K(M)157121); KALLAR: 4 August 2006, Arun Kumar AK428.

Discussion: Characteristics of the examined specimens agree very well with those of *Cystolepiota fumosifolia* from the Netherlands described by Vellinga & Huijser (1998) and Vellinga (2001). The Kerala collections, however, lack the pinkish tinge on fruit bodies at maturity and on bruising. A closely related species, *C. hetieri* (Boud.) Singer, differs by the absence of yellowish contents in its cystidia. This is the first record of this species from Asia.

Cystolepiota pulverulenta (Huijsman) Vellinga, Persoonia 14: 407 (1992)

Selected description and figures: Vellinga (1992: 407–410)

Pileus 7–8 mm diam., subglobose when young, becoming broadly convex and finally applanate with an indistinct obtuse umbo; surface whitish with a pale brown tinge towards the disc, granular, downy-wooly, or floccose; margin incurved, becoming straight, appendiculate; lamellae free, white, moderately crowded, less than 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides; stipe 15–32 × 1–2 mm; context less than 1 mm thick, white; odour not distinctive; spore print not obtained.

Spores 4–6 × 2–3 (4.85 ± 0.52 × 2.7 ± 0.3) µm, Q = 1.5-2, Qm = 1.66, subcylindric to cylindric, hyaline, with refractive guttules, thin-walled, smooth, vaguely dextrinoid, metachromatic in cresyl blue, cyanophilic in cotton blue; basidia 10–20 × 6–7 µm, clavate, with guttulate contents, bearing 4 sterigmata up to 3 µm long; cheilocystidia absent; pleurocystidia absent; pileal covering a trichodermium formed of irregular chains of inflated, ellipsoid, fusoid or cylindrical elements, 10–59 × 4–15 µm, arising from repent, 2–13 µm wide, thin-walled, filamentous hyphae. All hyphae lack clamp-connections.

Habitat: On soil and among decaying leaf litter, solitary or scattered in groups.

Collections examined — **INDIA, Kerala State, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 9 November 2004, Arun Kumar AK182; 26 September 2006, Arun Kumar AK444; 27 September 2006, Arun Kumar AK444a; 29 September 2006, Arun Kumar AK450 (K(M)157122).

Discussion: The metachromatic reaction of the spores in cresyl blue, the shape of pileal elements, and the absence of clamp-connections suggest placement of this species in the genus *Leucoagaricus*, but Vellinga (1992) justified its position in *Cystolepiota* owing to the flocculose covering of pileus and stipe, shape and size of spores resembling those of *Cystolepiota* species, spores that are not dextrinoid, and the absence of cheilocystidia. In view of her arguments (Vellinga 1992), and on the basis of molecular evidences (Vellinga 2003, 2004), this species is currently considered under the genus *Cystolepiota*. This is the first record of this species from India.

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We express our gratitude to Dr. Else C. Vellinga and Dr. P. Brandon Matheny for reviewing our manuscript and providing valuable suggestions.

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Taxonomy and nomenclature of powdery mildew fungi: *Erysiphe asclepiadis*, *E. robiniicola* and *Golovinomyces caulicola*

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Abstract — The new species *Erysiphe asclepiadis* is described, illustrated and discussed. A new Chinese collection of *Erysiphe robiniicola* has recently been found that can be used to elucidate and discuss the confused taxonomy and nomenclature of this species and other taxa of *Erysiphe* s. lat. on *Robinia* spp. Based on a re-examination of type material in connection with the data given in the protologue, it can be shown that *Capnodium lygodesmiae* must be reduced to synonymy with *Ampelomyces quisqualis*. The confusion surrounding the name *C. lygodesmiae*, caused by the occurrence of the hyperparasite *A. quisqualis* on a powdery mildew fungus with abundant chasmothecia, is discussed in detail. The new combination, *Golovinomyces caulicola* (≡ *Spolverinia caulicola*), is proposed for the powdery mildew that serves as host of *C. lygodesmiae*.

Key words — *Erysiphaceae*, *Asclepias*, *Lygodesmia*

Introduction

The powdery mildews (*Erysiphales*) represent one of the most common groups of biotrophic fungi. They occur on a wide range of host plants including numerous ornamental and other important cultivated plants, and the distribution of many

of these fungi is cosmopolitan. Taxonomy and phylogeny of the *Erysiphales* in comparison with many other fungal groups is relatively well-known due to a monograph published by Braun (1987) and numerous phylogenetic examinations (Takamatsu et al. 1999, 2000; Hirata et al. 2000, Mori et al. 2000, Khodaparast et al. 2001, Braun et al. 2002, Matsuda & Takamatsu 2003, Hirose et al. 2005). Nevertheless, numerous taxonomic problems are still unresolved, various compound species (species complexes) are not yet treated in detail, and the knowledge on numerous powdery mildew diseases is insufficient since they are only known as anamorphic states. In the present paper, we try to reduce this knowledge gap. A new species is described, and the nomenclature and taxonomy of some older names is reassessed and discussed.

Materials and methods

The collections were mounted in distilled water and examined for description by means of standard light microscopy (Olympus BX 50, Hamburg, Germany) using oil immersion (bright field and phase contrast), but without any staining. Thirty measurements (× 1000 magnification) of conidia and other structures were made. The extremes are given in parentheses. The collections examined are deposited in the herbaria, BPI, HAL and NY (abbreviations according to Holmgren et al. 1990), and the Mycological Herbarium of the Tarim University, Xinjiang, China (HMTRM).

Taxonomy

1. A new species of the genus *Erysiphe* on *Asclepias tuberosa*

Erysiphe asclepiadis U. Braun & V. Kumm., **sp. nov.** — Fig. 1

MycoBank, MB 512507

E. pachypodiae *similis, sed conidiis latioribus, 28–45 × 15–24 µm, ratione longitudinis/latitudinis (1.4–)1.5–2(–2.2), tubis germinalibus cum septis, appendicibus chasmotheciorum numerosis, brevioribus, apice non circinato.*

Etymology: derived from the host genus.

Material examined: GERMANY. Brandenburg, Potsdam, Botanical Garden, on *Asclepias tuberosa* L. (*Apocynaceae* [*Asclepiadoideae*]), 7 Sep. 2004, V. Kummer *1457/Asclepias 1* (HAL 2273 F, holotype), holomorph; 15 Sep. 2008 (herb. V. Kummer *1457/Asclepias 2*), anamorph; 23 Sep. 2008 (HAL 2274 F), anamorph; 2 Oct. 2008 (herb. V. Kummer *1457/Asclepias 4*), holomorph.

Mycelium epiphyllous, in white patches or effuse, thin to moderately thick; hyphae branched, 3–8 µm wide, septate, hyaline, thin-walled, smooth to somewhat rough-walled. Appressoria solitary or in opposite pairs, 3–8 µm diam., slightly to strongly lobed, occasionally nipple-shaped. Conidiophores arising from superficial hyphae, position between two septa non-central,

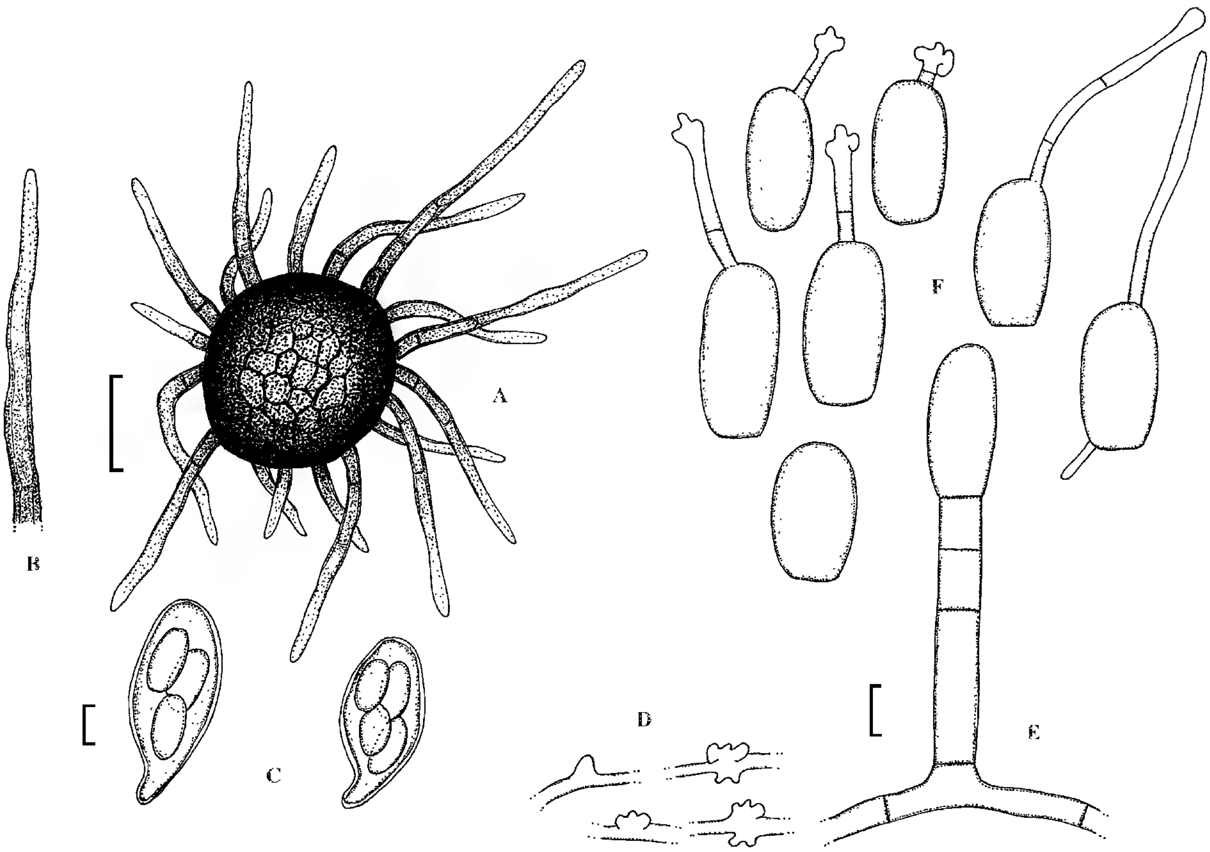

Fig. 1. *Erysiphe asclepiadis* (based on type material). **A.** Chasmothecium. **B.** Appendage. **C.** Asci. **D.** Appressoria. **E.** Conidiophore. **F.** Conidia with and without germ tubes. Scale bars = 50 µm (A, B), 10 µm (C–F). U. Braun del.

erect, straight, 40–90 µm long (without conidia), foot-cells 15–40 × 7–10 µm, cylindrical, straight, followed by 1–2(–3) shorter cells. Conidia formed singly, broadly ellipsoid(-ovoid), doliiform, 28–45 × 15–24 µm, length/width ratio (1.4–)1.5–2(–2.2), ends rounded to subtruncate, germ tubes terminal or subterminal, mostly short, with a terminal slightly to strongly lobed appressorium and a distinct septum in the lower half, some germ tubes (up to 25 %) long, up to six times as long as the conidial length, either without terminal appressorium and without septum or with a somewhat swollen, unlobed to slightly lobed appressorium and two septa, one septum in the lower and one in the upper half, i.e. the formation of septa in the germ tubes is initiated by the formation of terminal appressoria. Chasmothecia scattered to gregarious, immersed in the mycelial felt, 75–115(–120) µm diam., subglobose; peridial cells irregularly polygonal, 10–25(–30) µm diam. Appendages numerous, equatorial and in the lower half, 0.5–2 times as long as the chasmothecial diam. (up to 210 µm in length), (3–)4–10(–12) µm wide, somewhat narrower towards the apex, straight or almost so and stiff to flexuous, mycelioid, sinuous-subgeniculate, unbranched, (0–)1–3(–4)-septate, hyaline or brown

below and paler or colorless towards the apex, wall somewhat thickened below, up to 2 µm, thinner towards the apex, irregularly rough-walled. Asci 4–6 per chasmothecium, broadly obovoid to saccate, short-stalked, 50–70 × 30–45 µm, wall up to 3 µm thick, terminal oculus not very conspicuous, 10–20 µm diam., 3–5-spored, ascospores ellipsoid(-ovoid), colorless, (15–)20–26(–30) × 8–15 µm.

Comments: Lebeda et al. (2002, 2005) described *Erysiphe pachypodii* Lebeda et al. from the Czech Republic on potted plants of *Pachypodium lamerei* Drake cultivated in a private house. This is the only other species of the genus *Erysiphe* DC. described on a host belonging to the family *Apocynaceae* (including *Asclepiadaceae*). The size of the chasmothecia and the number and size of asci and ascospores agrees well with those of *E. asclepiadis*. However, *E. pachypodii* differs from the latter species in having a smaller number of appendages per chasmothecium. The appendages are much longer, 1.5–4 times as long as the chasmothecial diam. (up to 441 µm). Most of the appendages are simple with undifferentiated apices, but the tips of some appendages become circinate. In this respect, *E. pachypodii* can be considered one of the *Erysiphe* species intermediate between the Sections *Erysiphe* and *Uncinula* (Lév.) U. Braun & Shishkoff. Circinate tips of the appendages have not been observed in *E. asclepiadis*. The anamorph of *E. pachypodii* is quite distinct from the conidial state of *E. asclepiadis* by its much narrower, cylindrical conidia, 29.28–41.94 × 8.76–13.56 µm, length/width ratio 2.33–4.3 (according to the original description). Furthermore, *E. asclepiadis* is characterized by a pattern of conidial germination that is characterized by the formation of germ tubes with distinct septa.

2. *Erysiphe robiniicola* and other species of *Erysiphe* s. lat. on *Robinia* spp.

Tai (1946) introduced the name *Microsphaera robiniae* based on a Chinese collection on *Robinia pseudoacacia*. Braun (1987) re-examined type material of this species and published a comprehensive description and illustration. Based on the new generic taxonomy of the *Erysiphales* supported by molecular sequence analyses, Braun & Takamatsu (2000) assigned *Microsphaera robiniae* to *Erysiphe* emend. U. Braun & S. Takam. (incl. *Microsphaera* Lév.) under the new name, *Erysiphe robiniicola*, since the epithet '*robiniae*' was already occupied in *Erysiphe*. Tai's species on *Robinia* is characterized by having numerous mycelioid appendages, at first simple, but later irregularly branched. In the monograph of the Chinese *Erysiphales*, Chen et al. (1987) confused *M. robiniae*, known only from the type collection, with *M. subtrichotoma*, another rather common Chinese powdery mildew on *Robinia* characterized by straight, setiform, terminally regularly branched appendages. This was probably based on the assumption that the type material of this species represented an

abnormal collection. This powdery mildew species was described by Braun (1985) and later reallocated to *Erysiphe* (Braun & Takamatsu 2000). Braun (1987) emphasized the close morphological affinity of this species with *Erysiphe palczewskii* (≡ *Microsphaera palczewskii*). Heluta (1989) listed a collection of *M. palczewskii* on *Robinia pseudoacacia* from the Ukraine and reduced *M. subtrichotoma* to synonymy with the former species. Shin (2000) followed the taxonomy of Chen et al. (1987) and assigned Korean *E. palczewskii*-like collections on *Robinia* to *M. robiniae*. *Microsphaera indigoferae* H.D. Shin & Y.J. La (≡ *Erysiphe indigoferae* (H.D. Shin & Y.L. La) U. Braun & S. Takam.) was introduced for morphologically similar collections on *Indigofera* spp. (Shin 1988), whereas Chen et al. (1987) included Chinese material on *Indigofera* in *M. robiniae*. A new Chinese collection of *E. robiniicola* on the new host *Robinia hispida*, which represents the second collection of this species, agrees well with the type material except for somewhat shorter, less frequently branched appendages and a smaller number of 3–5(–6)-spored asci. However, unbranched appendages are also not uncommon in the type material of *E. robiniicola*. Furthermore, the new collection allowed an examination of the anamorph of *E. robiniicola,* which up to now has not been known in detail.

Erysiphe robiniicola U. Braun & S. Takam., Schlechtendalia 4: 13, 2000 FIG. 2

≡ *Microsphaera robiniae* F.L. Tai, Bull Torrey Bot. Club 73: 118, 1946, non *Erysiphe robiniae* Grev. 1824.

MATERIAL EXAMINED: CHINA. GANSU, Tiensuei, on *Robinia pseudoacacia* L., 10 Oct. 1943, Siang *197* (HMAS 05523), holotype of *M. robiniae.* CHINA. XINJIANG, Aksu, Taklimakan Desert, on *Robinia hispida* L., 20 Oct. 2006 and 25 Aug. 2008, Biao Xu (HAL 2271 [A, B] F, and Mycological Herbarium of the Tarim University, Xinjiang, China, HMTRM).

DESCRIPTIONS: Braun (1985: 92; 1987: 314).

ILLUSTRATIONS: Tai (1946: 119, Fig. 6), Braun (1985: 91, Fig. 4; 1987: 315, Plate 92).

Description based on material on *Robinia hispida*: MYCELIUM in thin white patches, causing necrotic discolorations; hyphae branched, hyaline, septate, thin-walled, 2–7 µm wide. APPRESSORIA solitary, one or two, occasionally even three per cell, slightly to distinctly lobed, occasionally nipple-shaped, 2–7 µm diam. CONIDIOPHORES arising from superficial hyphae, position between two septa more or less central to somewhat non-central, erect, up to 100 µm long (without conidia), foot-cells straight, cylindrical or occasionally somewhat curved or sinuous, 30–65 × 5–7(–9) µm, followed by 1–3 shorter cells, basal septum occasionally somewhat distant from the supporting hypha, up to 10 µm. CONIDIA solitary, cylindrical to ellipsoid, (25–)30–40 (–50) × 12–18 µm, length/width ratio 2.0–3.6. CHASMOTHECIA scattered to gregarious, amphigenous, mostly epiphyllous, 85–125 µm diam.; peridial cells irregularly polygonal, 5–25 µm diam. APPENDAGES numerous, equatorial or

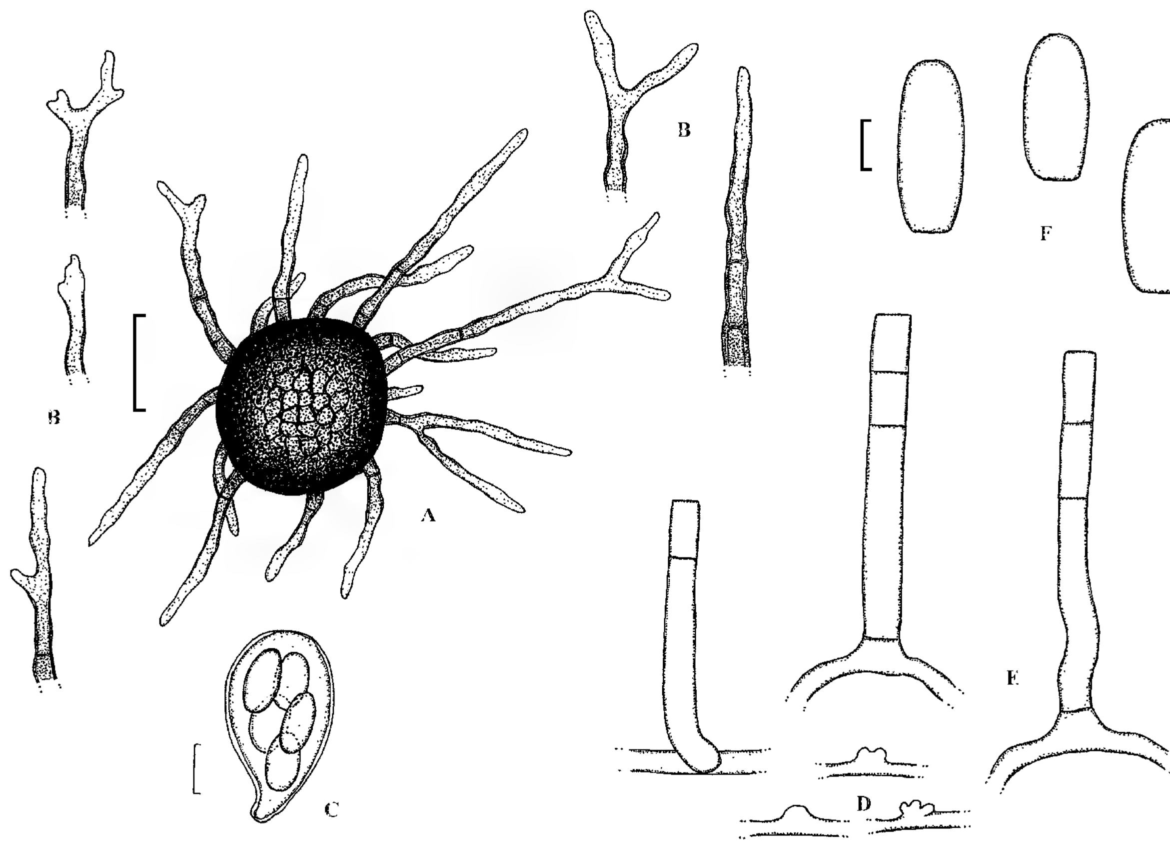

Fig. 2. *Erysiphe robiniicola* (based on HAL 2271 F). **A.** Chasmothecium. **B.** Appendages. **C.** Ascus. **D.** Appressoria. **E.** Conidiophores. **F.** Conidia. Scale bars = 50 µm (A, B), 10 µm (C–F). U. Braun del.

in the lower half, 0.25–2 times as long as the chasmothecial diam., 3–10 µm wide, mycelioid, irregularly shaped, mostly unbranched, but some appendages 1–3 times terminally irregularly branched, rarely branched at the base, short appendages sometimes almost coralloid, 0–3-septate, hyaline, later pigmented below and paler to hyaline towards the apex or brownish throughout, thick-walled below, up to 2 µm, thinner towards the apex, smooth to rough-walled. Asci 4–7, saccate, short-stalked, 40–60 × 25–40 µm, wall up to 3 µm broad, terminal oculus 10–15 µm wide, 3–5(–6)-spored; ascospores 15–22 × 9–14 µm, ellipsoid-ovoid, colorless.

Erysiphe subtrichotoma is unknown in North America although *Robinia* is a North American genus. This raises the question regarding the origin of this powdery mildew fungus. It is more probable that *Robinia* spp. are attacked in Asia by an indigenous Asian powdery mildew species. *E. subtrichotoma* is morphologically indistinguishable from *E. palczewskii*. Schmidt & Scholler (2002) recorded and described the latter species on *Colutea arborescens* from Germany and demonstrated that this fungus was able to expand its host range. Therefore, we follow Heluta's (1989) taxonomic treatment and reduce *E. subtrichotoma* to synonymy with *E. palczewskii*.

Erysiphe palczewskii (Jacz.) U. Braun & S. Takam., Schlechtendalia 4: 12, 2000
≡ *Microsphaera palczewskii* Jacz., Karmannyj opredelitel′ gribov. Tom. II. Muchnisto-rosjannye griby: 339, Leningrad 1927.

= *Microsphaera subtrichotoma* U. Braun, Mycotaxon 22: 90, 1985.
≡ *Erysiphe subtrichotoma* (U. Braun) U. Braun & S. Takam., Schlechtendalia 4: 14, 2000.

Host range and distribution: on *Caragana arborescens* Lam. (incl. *C. fruticosa* (Pall.) Besser), *C. boisii* C.K. Schneid., *C. brevispina* Benth., *C. decorticans* Hemsl., *C. densa* Kom., *C. frutex* K. Koch, *C. manshurica* (Kom.) Kom., *C. microphylla* Lam., *C. mollis* (M. Bieb.) Besser, *C. spinosa* (L.) Vahl ex Hornem., *C. ussuriensis* (Regel) Pojark., *Colutea arborescens* L., *Robinia hispida* and *R. pseudoacacia*, Asia (China, Kazakhstan, Korea, Russia, Turkmenistan), introduced in Europe (Austria, Belarus, Czech Republic, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, the Ukraine) and North America (Alaska, Idaho, Minnesota, North Dakota, Washington) [Braun 1987, Heluta 1998, Scholler 1994, Heluta & Minter 1998, Schmidt & Scholler 2002, Lebeda et al. 2008].

Erysiphe pseudacaciae (P.D. Marchenko) U. Braun & S. Takam. and *Erysiphe robiniae* are additional powdery mildew species of *Erysiphe* emend. (incl. *Microsphaera*) described from *Robinia* species. The latter species belongs, however, to the *Erysiphe trifolii* Grev. complex. Blumer (1933, 1967) and Braun (1987) reduced *E. robiniae* to synonymy with *E. trifolii*. Species of *Erysiphe* s. lat. on *Robinia* can be keyed out as follows:

1 Appendages very long, 2–12 times as long as the chasmothecial diam., often turning towards one direction, flexuous, but not mycelioid 2
1 Appendages shorter, 1–3 times as long as the chasmothecial diam., either stiff, setiform or mycelioid, irregular 3

2 Appendages unbranched or occasionally some appendages 1–2(–3) times loosely dichotomously branched, tips of the ultimate branchlets straight .... *Erysiphe trifolii*
2* Appendages terminally 1–5 times branched, irregular to rather regular, tips of the ultimate branchlets at least partly recurved when mature .... *Erysiphe pseudacaciae*

3 Appendages stiff, setiform, continuous or with a single septum at the base, terminally 4–6 times regularly and densely branched, ultimate tips straight .... *Erysiphe palczewskii*
3* Appendages flexuous, mycelioid, 0–3-septate, unbranched to 1–5 times irregularly branched .... *Erysiphe robiniicola*

3. *Capnodium lygodesmiae* and *Spolverinia caulicola*

The first reassessment of the "sooty mould" *Capnodium lygodesmiae* dates back to Theissen (1917), who introduced the combination, *Erysiphe lygodesmiae*, based on abundant chasmothecia of a powdery mildew fungus in authentic collections of this species. Ciferri & Batista (1956) examined syntype material of

C. lygodesmiae (Ellis & Everhart, North American Fungi 3216) deposited at BPI and emphasized that they were unable to find any capnodiaceous fungus. They supposed that *C. lygodesmiae* was based on an imperfect sooty mold fungus. However, they found in the type material a "sphaeriaceous fungus" that they described as *Spolverinia caulicola*. In order to clarify the confused taxonomy and nomenclature surrounding *C. lygodesmiae*, type material of this species deposited at NY has been re-examined and the results have been compared with the original data given in the protologue.

Type material of *Capnodium lygodesmiae* contains abundant chasmothecia and superficial mycelium of a powdery mildew fungus strongly infected by the hyperparasite, *Ampelomyces quisqualis*. A collection at NY (ex herb. Ellis, with a handwritten label) was annotated as the holotype, but it should rather be considered a syntype among numerous other duplicates deposited at BPI, NY and various other herbaria that include collections distributed as Ellis & Everhart, North American Fungi 3216 and Fungi Columbiani 616. Therefore, the collection from NY is proposed here to serve as lectotype of *C. lygodesmiae*. This specimen is characterized by having few chasmothecia, but it has abundant mycelium strongly infected by *A. quisqualis*. The white mycelial patches at stems of the host plant turned brownish due to severe infections by this hyperparasite. The original description of *C. lygodesmiae* obviously refers to the hyperparasite: "Perithecia numerous, globose, ovate, or oblong-elliptical, 20–90 × 20–40 µm, … Sporules not abundant, oblong-elliptical, 5–8 × 3 µm, hyaline." Therefore, the name *C. lygodesmiae* is confined to the *A. quisqualis* element of the type material in accordance with ICBN Art. 9.12:

Ampelomyces quisqualis Ces., Bot. Zeitung (Berlin) 10: 301, 1852.

= *Capnodium lygodesmiae* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 47: 414, 1895, **syn. nov.**

≡ *Limacinia lygodesmiae* (Ellis & Everh.) Sacc. & P. Syd., in Saccardo, Syll. fung. 14: 476, 1899.

≡ *Erysiphe lygodesmiae* (Ellis & Everh.) Theiss., Ann. Mycol. 15: 277, 1917.

Material examined: USA. Colorado, Fort Collins, on living leaves of *Lygodesmia juncea* (Pursh) D. Don ex Hook. (*Asteraceae*), 10 Oct. 1894, C.F. Baker 293 (NY), lectotype of *C. lygodesmiae* designated here.

Theissen (1917) confused *A. quisqualis*, which was the base for the description of *C. lygodesmiae*, with its host, a powdery mildew belonging in the *Golovinomyces cichoracearum* (DC.) Heluta complex, and he introduced the combination, *Erysiphe lygodesmiae*. Ciferri & Batista (1956) examined syntype material of *C. lygodesmiae* from BPI, but they did not confuse this "sooty mould" with the ascomata found at the stems of *Lygodesmia juncea*. Since they did not realize that the ascomycete involved pertained to the powdery mildews (*Erysiphales*), they assigned it to the little-known, doubtful genus *Spolverinia* A. Massal.

(Massalongo 1855–56) and provided a full description and illustration under the name, *S. caulicola* (as '*caulicolum*'). Junell (1964) examined type material of *Spolverinia punctum* A. Massal., the type species of the genus, and demonstrated that this species was based on ascomata of *Phyllactinia* sp. (powdery mildew fungi) blown on the thallus of a lichen. The host of *C. lygodesmiae* is, however, a species of the powdery mildew genus *Golovinomyces* (U. Braun) Heluta that is characterized by having nipple-shaped appressoria, conidia formed in chains and chasmothecia with two-spored asci. Braun (1987) used the misapplied name *Erysiphe lygodesmiae* and reduced it to synonymy with *Erysiphe cichoracearum* DC., now *Golovinomyces cichoracearum*. However, the *Lygodesmia* powdery mildew is morphologically sufficiently distinct from *G. cichoracearum* — by its small (only 18–28 × 12–15 µm) conidia, chasmothecia with very short, often rudimentary appendages, and 2–3-spored asci — that it should be considered a separate species:

Golovinomyces caulicola (Cif. & Bat.) U. Braun, **comb. nov.** FIG. 3

MycoBank MB 512508

≡ *Spolverinia caulicola* ('*caulicolum*') Cif. & Bat., An. Soc. Biol. Pernambuco 14(1–2): 62, 1956.

= *Erysiphe lygodesmiae* auct.

= *Erysiphe cichoracearum* auct. p.p.

HOLOTYPE: USA. COLORADO, Fort Collins, on living leaves of *Lygodesmia juncea* (*Asteraceae*), Oct. 1894, C.F. Baker, Ellis & Everh., North American Fungi 3216 (BPI 600002), holotype of *S. caulicola*.

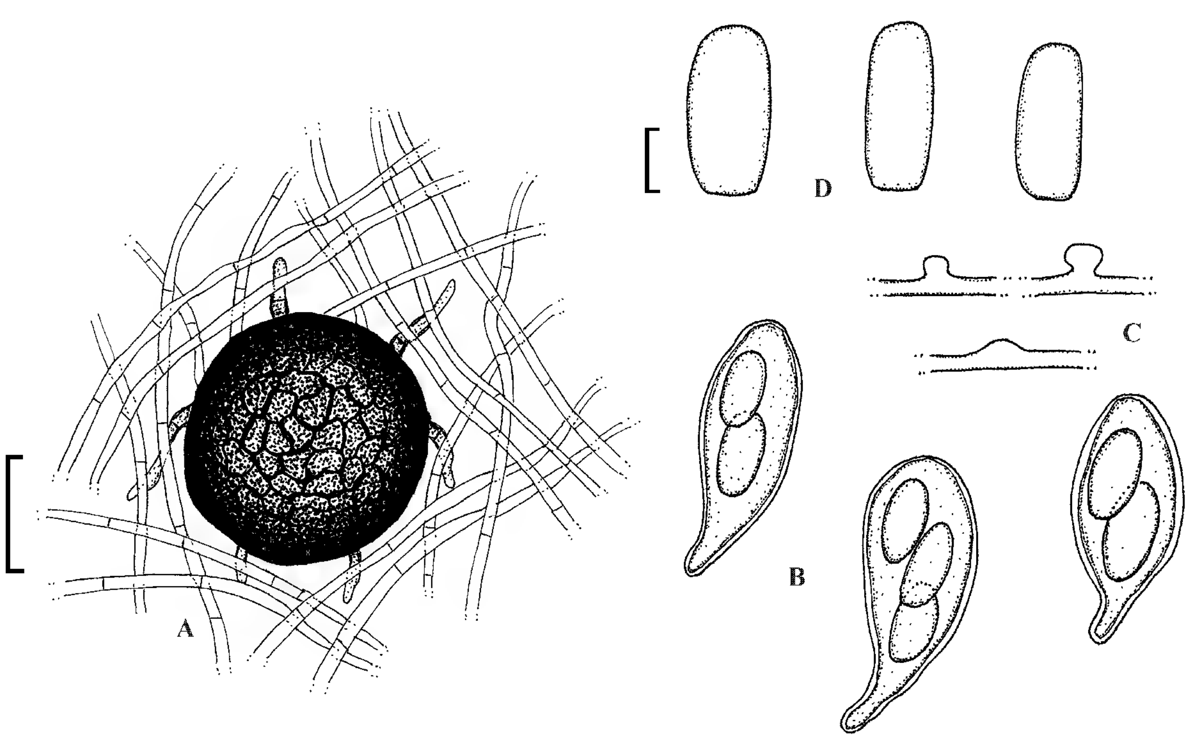

FIG. 3. *Golovinomyces caulicola* (based on type material). A. Chasmothecium. B. Asci. C. Appressoria. D. Conidia. Scale bars = 50 µm (A), 10 µm (B–D). U. Braun del.

Material examined: Ellis & Everh., North American Fungi 3216 and Ellis & Everh., Fungi Columbiani 616 (NY 00830153–00830155, 00985691, 00985692), isotypes of *S. caulicola*.

Illustration: Ciferri & Batista (1956: 64, Fig. 1).

Mycelium forming persistent, dense, thick, white patches or covers on stems; hyphae branched, septate, 2–5 µm wide, thin-walled, smooth to rough-walled, white, with age turning yellowish to pale brownish. Appressoria nipple-shaped, 3–6 µm diam. Chasmothecia immersed in the mycelial felt, scattered to gregarious, 70–120 µm diam.; peridial cells irregularly shaped, 10–25(–30) µm diam., walls in front view undulate, thin, 0.5–1.5 µm wide. Appendages few to numerous, shorter than the chasmothecial diameter, sometimes very short and rudimentary, barely distinguishable from the hyphae, mycelioid, unbranched, 3–7 µm wide, septate, thin-walled, smooth, hyaline, later somewhat pigmented. Asci 4–8 per chasmothecium, saccate, short-stalked, wall thin, ca. 1 µm, 2–3-spored, ascospores broadly ellipsoid-ovoid, hyaline, 20–30 × 10–16 µm.

Acknowledgements

Thanks are due to the curators of the herbaria BPI, HMAS and NY for the possibility to examine type material in their possession. We are much obliged to Andrew Minnis, (USDA, ARS, Systematic Mycology and Microbiology Laboratory, Beltsville, USA) and Markus Scholler (Staatliches Museum für Naturkunde, Karlsruhe, Germany) for providing pre-submission reviews.

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Microsphaeropsis caloplacae sp. nov. on *Caloplaca persica* in Turkey

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Abstract — A new lichenicolous coelomycete, *Microsphaeropsis caloplacae,* is described from the apothecial discs of *Caloplaca persica* in Turkey.

Keywords — *Ascomycota,* lichens, lichenicolous fungus, taxonomy

Introduction

The diversity and distribution of lichenicolous fungi in Turkey is poorly known, particularly in comparison to that from other European countries (Diederich et al. 2007, Etayo 2008, Hawksworth 2003, Suija 2005a,b, Zhurbenko et al. 2008). Hafellner & John (2006) reported 63 lichenicolous fungal taxa in Turkey, thus stimulating interest in lichenicolous fungi so that an additional 63 species were subsequently described from the country (Candan & Halıcı 2008; Candan & Özdemir-Türk 2008; Halıcı 2008; Halıcı et al. 2008; Halıcı & Candan 2007; Halıcı & Hawksworth 2007, 2008; Yazıcı & Aslan 2006, 2007). Approximately 127 species of lichenicolous fungi have now been reported from Turkey (Candan & Özdemir-Türk 2008, Halıcı 2008a,b). Below we describe a new lichenicolous coelomycete species, *Microsphaeropsis caloplacae*, that infects the apothecial discs of *Caloplaca persica* (J. Steiner) M. Steiner & Poelt.

Material and methods

The fungus was studied using a Meiji zoom stereomicroscope and an Olympus CH microscope. Microscopical measurements were determined from hand-sectioned tissues examined in water. The material studied and collected by the authors is deposited in the herbarium of Biology Department, Karadeniz Technical University (KTUB).

Taxonomy

Microsphaeropsis caloplacae Etayo & Yazici, **sp. nov.** PLATE 1
MycoBank mb 512687

Fungus lichenicola in thallo et apotheciis Caloplacae persicae *crescens. Conidiomata pycnidia, singularia, pyriformia vel subglobosa, immersa, nigra, ostiolata, 30–50 µm in diam. Paries fuscus, c. 5 µm crassus et textura angularis. Conidia late ellipsoidea, brunnea, laevia, 7.2–8.3 × 4–6 µm.*

Holotype: Turkey, Sivas, Center, along the Kızılırmak river, 39°43'35" N, 37°02'24" E, alt. 1300 m, on the apothecial discs of *Caloplaca persica* on *Populus* sp., 17 August 2006, Yazici 0.1550 (KTUB–Biology Department, Faculty of Sciences and Arts, Karadeniz Technical University–***holotypus***, , hb. Etayo-***isotypus***).

Etymology: The epithet "*caloplacae*" refers to the host species

Description: Pycnidia completely immersed in the apothecial discs of the host lichen, single, punctiform, hardly visible, blackish in surface view, pyriform to subglobose, 30–50 µm diam., ostiolate, without a distinctly thickened ostiolar collar; superficial and internal mycelium absent. Pycnidial wall c. 5 µm thick, composed of one layer of brown, paraplechtenchymatic cells of 4–7 µm in diam., almost hyaline in the basal part. Conidiophores absent. Conidiogenous cells rarely observed, apparently lining the inside of the pycnidial cavity, hyaline, broadly ampulliform and applanate, 4–7 µm wide. Conidia filling the pycnidial cavity, enteroblastic, arising singly, not catenate, broadly ellipsoid with some vertical constrictions, aseptate, young walls hyaline but soon brown, smooth and easily broken by pressure, rounded at both ends, without basal scar, 7.2–8.3 × 4–6 µm, length/breadth ratio 1.2–1.8 (n=30).

Distribution and habitat – The new species is known only from the type locality. Although the apothecial disc of *Caloplaca persica* is darkened by the presence of the lichenicolous fungus, the hymenium goes on producing ascospores normally, and therefore the infection seems not to be strongly pathogenic. The darkening of the parasitized apothecia is due not only to the pycnidia but also to the ascospores of the fungus and hyphae produced by spore germination. Living with *M. caloplacae* in the type locality is a *Lichenodiplis* species with spores similar to *L. lichenicola* Dyko & D.Hawksw. in size.

Ecology of the survey area – The type locality, Sivas, has a continental climate with hot and dry summer seasons and cold, rainy, snowy and windy winters. Steppe vegetation dominates plateaus and hills. The well-lit site, which is occasionally exposed to strong winds in winter, has an elevation of 1300 m and lies 50 m from the Kızılırmak River. *Acer*, *Populus* and *Pyrus* trees are occasionally present along the Kızılırmak River. Temperatures range from −34.6° C in winter to +38.3° C in summer. The atmospheric humidity varies between 55 and 80 %. The mean annual rainfall is 420 mm (Akman 1999).

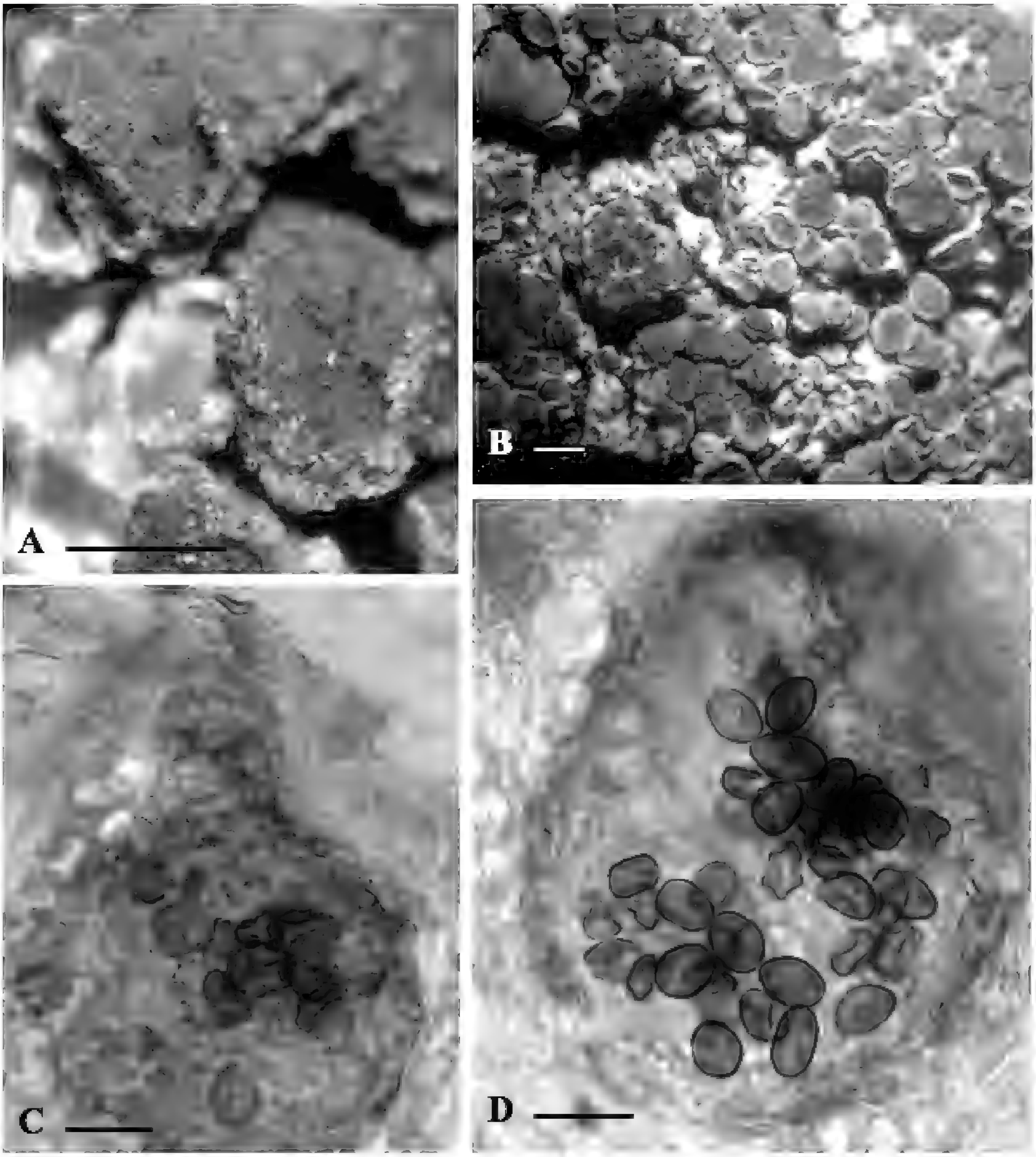

PLATE 1. A: Apothecia of *Caloplaca persica* infected by *Microsphaeropsis caloplacae*. B: Comparison of infected apothecia (left, darkened) and uninfected apothecia (right). C–D: *M. caloplacae* pycnidia completely immersed in the host apothecia. C: Apical papilla (top) comprises one row of cells concolorous with the pycnidial wall. D: Darkened conidia within the pycnidial cavity.
Scale bars: A, B = 0.5 mm; C, D = 10 µm.

Discussion

The new species is placed with some hesitation into the coelomycete genus *Microsphaeropsis* Höhn., a genus that normally infects plant leaves. In the studied material it was not possible to observe well developed conidiogenous cells, although several structures similar to such cells (but more applanate than) seem to exist in *Microsphaeropsis*. As the other features do not fit with any of

the known lichenicolous coelomycetes, we decided to refer the new species provisionally to this genus. Another lichenicolous species, *Microsphaeropsis lichenicola* Etayo, growing on several species of macrolichens (*Hypotrachyna*, *Nephroma*, *Pannaria*) in southern Chile, has recently been described (Etayo & Sancho 2008). Besides the different hosts, that taxon has larger (c. 100 µm diam.) pycnidia and thicker pycnidia (8–10 µm) and cell (5–12 µm) walls.

A similar lichenicolous species has recently been described as *Acaroconium punctiforme* Kocourk. & D. Hawksw. (Kocourková & Hawksworth 2008). This genus is said to be distinguished from *Microsphaeropsis* by possession of a differentiated ostiolar collar and broadly ellipsoid to somewhat irregular conidia. Although we think that both characters, and especially the last one, are not sufficient to differentiate between two genera, further studies are needed to determine whether *Acaroconium* and *Microsphaeropsis* represent one genus. Seephonkal et al. (2002) were able to isolate the type species of *Microsphaeropsis*, *M. olivacea* (Bonord.) Höhn., which is common on twigs and branches of various trees, from the lichen *Dirinaria applanata* in Thailand. This species has much larger (200–240 × 160–200 µm) pycnidia and smaller, narrower (5.5–6.5 × 3.2–3.4 µm) conidia (Hoog et al. 2000) than *M. caloplacae*. The similar genus *Phoma* Sacc. (1880), which also includes several lichenicolous species, differs primarily in having hyaline conidia and with most species inhabiting phanerogams (Hawksworth 1981, Hawksworth & Cole 2004).

Acaroconium punctiforme differs from our new species in pycnidial size (50–100 µm diam.), the absence of a thicker ostiolar collar at the pycnidial apex, and the irregularly shaped, ellipsoid conidia (see FIG. 1D in Kocourková & Hawksworth 2008).

Key to *Acaroconium* and *Microsphaeropsis* lichenicolous species

1. Conidioma large, 200–240 × 160–200 µm [conidia 5.5–6.5 × 3.2–3.4 µm, saprobic on several substrates, including *Dirinaria*]
 .... ***Microsphaeropsis olivacea*** (Bonord.) Höhn.

1. Conidioma smaller, ≤ 150 µm 2

2. Conidioma (50–100 µm diam.) with ostiolar collar, conidia irregular to ellipsoid, 5.5–7.5× 3.5–5 µm. On *Acarospora* and *Sarcogyne*
 .... ***Acaroconium punctiforme*** Kocourk. & D. Hawksw.

2. Conidioma (30–100 µm diam.) without ostiolar collar, conidia regular. Not on *Acarospora* or *Sarcogyne* 3

3. Conidioma ~100 µm diam., conidia ~6–7 × 4–5 µm (ellipsoid), on foliaceous austral lichens, e.g., *Hypotrachyna*, *Nephroma*, *Pannaria*
 .... ***Microsphaeropsis lichenicola*** Etayo

3. Conidioma smaller (30–50 µm diam.), conidia larger (7.2–8.3 × 4–6 µm), on apothecial discs of *Caloplaca* .... ***Microsphaeropsis caloplacae***

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Two new records of *Phyllachora* (*Phyllachorales*) from China

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Abstract— Two new Chinese records, *Phyllachora africana* on *Eremopogon delavayi* and *Phyllachora vulgata* on *Muhlenbergia racemosa* are reported.

Key words—*Sordariomycetidae*, tar spot, taxonomy

Introduction

The first report of *Phyllachora* in China was by Kalchbrenner & Thümen (1881), who listed *Phyllachora angelicae* (Fr.) Fuckel collected from Inner Mongolia. Sydow & Sydow (1920) first described a new species, *Phyllachora cantonensis* Syd. & P. Syd., from China. Sawada (1919, 1928, 1943, 1944) reported some *Phyllachora* species from Taiwan. Tai (1979) provided the first comprehensive account of the *Phyllachora* in China. Luo (1984) made a detailed study of *Phyllachora* inhabitating *Poaceae*. There have been several recent reports of *Phyllachora* in China (Zhang et al 2003, 2005; Liu & Guo 2006a, b, 2007).

Phyllachora on *Eremopogon*

A specimen of *Phyllachora* was collected from Tengchong on *Eremopogon delavayi* (Hack.) A. Camus [syn. *Andropogon delavayi* Hack.; *Schizachyrium delavayi* (Hack.) Bor], which is distributed across southwestern China. To date, *Phyllachora* has not been reported on *Eremopogon* in China. There are 8 species of *Phyllachora* on *Andropogon* and 3 species on *Schizachyrium* worldwide (Parbery 1967). The specimen that we collected was identified as *Phyllachora africana* based on the similar size and shape of ascospores as given by Parbery (1971). The type of *Phyllachora africana* was reported on *Echinochloa*. Both *Eremopogon* and *Echinochloa* belong to the subfamily *Panicoideae*.

*corresponding author

Phyllachora africana Parbery, Aust. J. Bot. 19: 211, 1971. FIGS. 1–2

LEAF SPOT: blackened regions sparse, ellipsoidal, slightly raising the host surface, 0.3–1.7 × 0.3–0.8 mm, multiloculate, the ostiole inconspicuous, blackened regions can be visible from both sides of the leaves.

ANAMORPH: not seen.

TELEOMORPH: ascomata 170–425 × 100–175 µm, epigenous, immersed in the mesophyll layer of the leaves, ellipsoidal, with flattened base, with neck extending through the host epidermis and cuticle to the surface, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 55 µm thick, composed of epidermal cells which are occluded by melanized material. Lower wall up to 15 µm thick. Lateral wall up to 20 µm thick, composed of thin-walled cells. Paraphyses up to 2 µm wide, thin-walled, gradually tapering, not branched, not septate. Asci 100–140 × 9–12.5 µm, with apical ring, 8-spored, cylindric, short pedunculate, thin-walled at maturity, unitunicate. Ascospores uniseriate, 10–17 × 5–9 µm, ovoid, one-celled, hyaline, thin-walled, smooth.

SPECIMENS EXAMINED–On living leaves of *Eremopogon delavayi* (*Poaceae*), Yunnan: Tengchong, alt. 1750 m, 20 IX 2005, N. Liu, Z.Y. Li & L.Guo 141, HMAS 171988.

Phyllachora on *Muhlenbergia*

A specimen of *Phyllachora* on *Muhlenbergia racemosa* (Michx.) Britton et al. collected from Jiangsu Province in 1903 was deposited in HMAS as *Phyllachora graminis* (Pers.) Fuckel. We found that it had been wrongly identified and redetermined it as *Phyllachora vulgata*, which to date is the only species reported on *Muhlenbergia* worldwide (Parbery 1967).

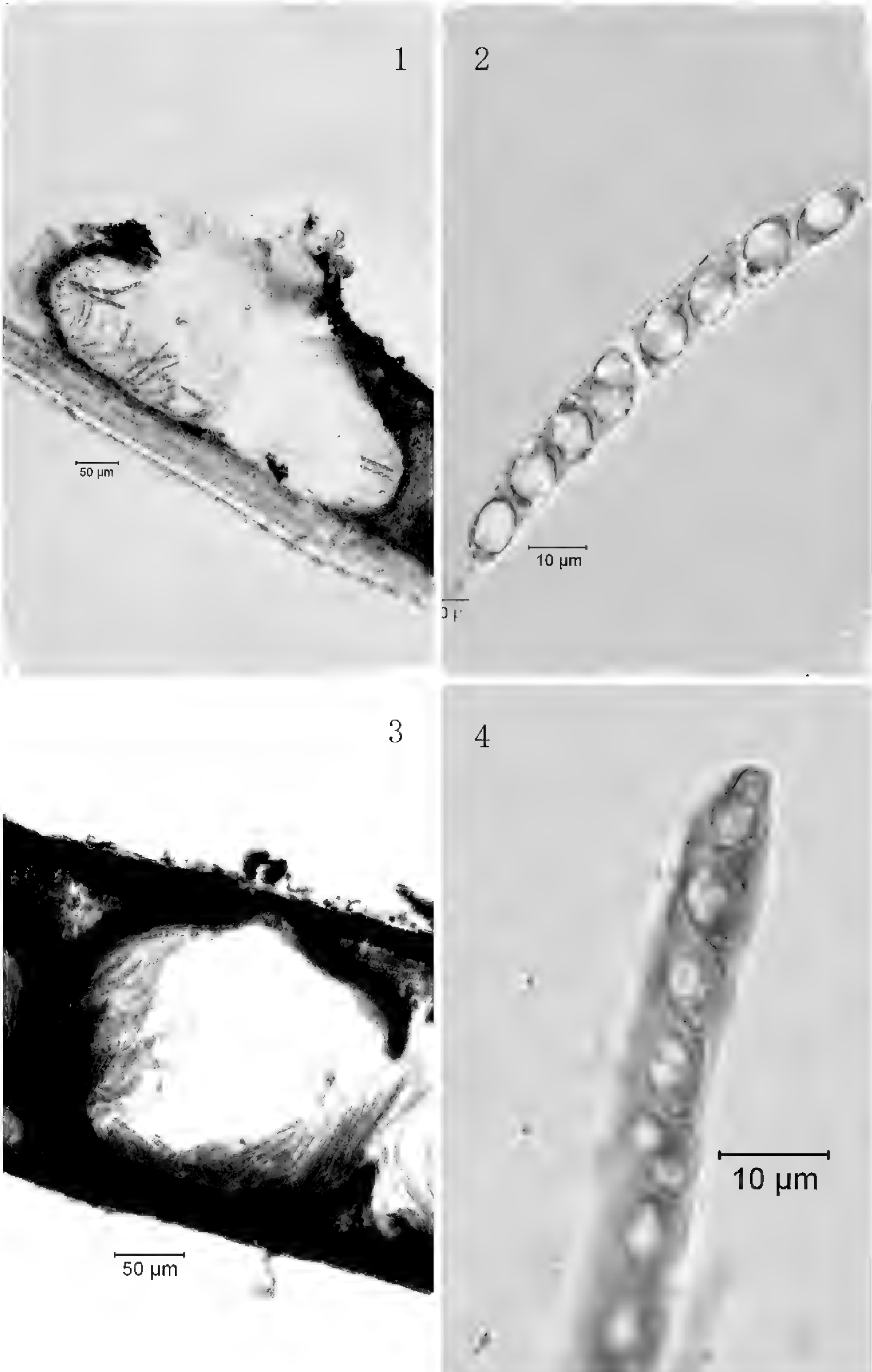
Phyllachora vulgata Theiss. & Syd., Ann. Mycol. 13: 450, 1915. FIGS. 3–4

LEAF SPOT: blackened regions sparse, long ellipsoidal, slightly rising from the leaf surface, 0.3–1.5 × 0.2–0.8 mm, shining black, multi-loculated, the ostiole inconspicuous, blackened regions can be seen from both sides of leaves.

ANAMORPH: not seen.

TELEOMORPH: ascomata 150–300 × 80–205 µm, immersed in the mesophyll layer of the leaves, subglobose, with neck extending through the host epidermis and cuticle to the surface, asci rising from the basal and lateral wall of the ascoma. Upper wall up to 50 µm thick. Lower wall up to 40 µm thick. Lateral wall up to 20 µm thick, composed of thin-walled cells. Asci 58–96 × 5–10 µm, 8-spored, clavate, obtuse at apex, short pedunculate, thin walled at maturity,

FIGS. 1–2. *Phyllachora africana*. FIG. 1. Section through immersed ascoma. FIG. 2. Ascus and ascospores FIGS. 3–4. *Phyllachora vulgata*. FIG. 3. Section through immersed ascoma. FIG. 4. Ascus and ascospores.


1
2
3
4
50 µm
10 µm
10 µm
50 µm

unitunicate. Ascospores uniseriate, 7–13 × 5–6 µm, ellipsoid or ovoid, one-celled, hyaline, smooth, without a gelatinous sheath.

Specimens examined–on living leaves of *Muhlenbergia racemosa* (*Poaceae*), Jiangsu: Nanjing, 19 IX 1903, HMAS 6828.

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The genus *Diatrype* (*Ascomycota, Diatrypaceae*) in Arkansas and Texas (USA)

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Abstract — Seven species of the genus *Diatrype* are recorded as occurring in Arkansas and Texas (USA). Two of these (*Diatrype caryae* and *D. ilicina*) are described and illustrated as new to science.

Key words — *Sordariomycetes,* south central United States, systematics

Introduction

Species of *Diatrype* are common inhabitants of dead branches of deciduous trees throughout the world. These fungi produce perithecia imbedded in discoid or widely effused stromata that are erumpent from the bark. The young stromata are sometimes covered with a layer of sterile tissue that eventually peels off to expose a fertile surface studded with papillate or stellate ostioles. Members of the genus *Diatrype* do not cause diseases of their host plants and mostly participate in the decomposition of coarse woody debris. However, despite their saprotrophic way of life, many species of *Diatrype* are restricted to certain genera of host plants.

Following the distribution of their host plants, some species of *Diatrype* occur over wide areas of the northern hemisphere. Prominent examples are *D. bullata* (Hoffm. : Fr.) Fr. on *Salix* spp. (willow) or *D. undulata* (Pers. : Fr.) Fr. on *Betula* spp. (birch). Among the more interesting are *D. virescens* (Schwein.) Ravenel on *Fagus grandifolia* Ehrh. (American beech) in North America and *D. disciformis* (Hoffm. : Fr.) Fr. on *Fagus sylvatica* L. (European beech) in Europe. The latter has been reported to be rare in North America, but the

monographer of the group (Rappaz 1987) has listed specimens only from Europe. We did not observe *D. disciformis* among specimens in any herbarium or represented by fresh material collected in North America. As such, all the records of this species in North America (Farr et al. 1989) need to be checked. With two different species of *Diatrype* on *Fagus* spp. on two continents, the third one, namely *D. decorticata,* occurs on the same hosts in both Europe and North America.

Diatrype tremellophora Ellis is restricted to *Magnolia* spp. (magnolia) in the eastern United States, as is the case for *D. atlantica* on *Quercus* spp. There are also several species known only from type localities in the United States. Examples are *D. concolor* (Schwein.) Cooke (on *Vaccinium corymbosum* L., blueberry), *D. subaffixa* (Schwein.) Cooke (on a twig of a member of the *Rosaceae*) from New Jersey and *D. bicolor* (Berk. & M.A. Curtis) Cooke (on an unidentified substrate) from Vermont. These observations give some indication of just how much remains to be done if we are to develop a more complete understanding of the true biodiversity and distribution of species of *Diatrype* in different regions of the world.

Pyrenomycetous fungi in general and members of the genus *Diatrype* in particular are poorly investigated in the south central United States. Most of the species assigned to *Diatrype,* collected in Texas and kept in the US National Fungus Collections (Beltsville, Maryland), do not belong to this genus. Thus, *D. atropunctata* is *Biscogniauxia atropunctata* (Schwein. : Fr.) Pouzar, *D. dryophila* is *Anthostoma dryophilum* (Curr.) Sacc., *D. gyrosa* is *Endothia gyrosa* (Schwein. : Fr.) Fr., *D. hypophlaea* is *Jumillera hypophlaea* (Berk. & Ravenel) J.D. Rogers & al., *D. microplaca* is *Whalleya microplaca* (Berk. & M.A. Curtis) J.D. Rogers & al., and *D. prominens* is *Cryptovalsa prominens* (Howe) Berl. The specimens of *Diatrype* sp. (BPI 577787 and 577789) on *Ilex opaca* Aiton (American holly) appear to be *Cryptovalsa opaca* (Cooke) Lar.N. Vassiljeva. As for species of *Diatrype* from Arkansas, there are four specimens of two species in the national herbarium (BPI). These are *Diatrype albopruinosa* (Schwein.) Cooke and *D. stigma* on *Quercus* spp. (oak). The occurrence of the latter species in Arkansas was confirmed by our collections, but they are all on *Carya* spp. (hickory), while *D. albopruinosa* was not found again.

Our previous paper on the genus *Diatrype* in North Carolina and Tennessee (Vasilyeva & Stephenson 2004) contains the descriptions of ten species. Only four of these—*Diatrype atlantica* and *D. stigmaoides* on *Quercus* spp., *D. decorticata* on *Fagus grandifolia* and *D. platystoma* on *Ostrya virginiana* (Mill.) K. Koch (hop-hornbeam)—were found again in two south central states, and the first three are especially frequent in the Big Thicket National Preserve. Specimens with the typical appearance of *D. platystoma* were encountered in Arkansas, but this species was essentially absent in Texas. One specimen that

is similar to *Diatrype discostoma* Cooke in Ravenel's Fungi Americani Exsiccati N 358 (in cortice *Carpini,* Gainesville, Florida) was collected in the Big Thicket. The name *D. discostoma* has been reduced to a synonym of *D. platystoma* (Rappaz 1987), but the absence of the typical form of *D. platystoma* in Texas and a record from Florida suggest that what has been recognized previously as *D. discostoma* might represent, at least at the level of variety, a separate taxon preferring a warmer climate.

Material and methods

The material considered herein was collected in 2005 (Ozark Mountains and Ouachita Mountains, Arkansas) and 2006 (Big Thicket National Preserve, Texas) by the first author. Microscopic analyses were carried out using standard techniques. The photographs were taken using Nikon D40x and Canon Power Short S40 digital cameras. Sections of stromata were photographed with a Leica MZ75 microscope.

Taxonomy

Diatrype atlantica Lar.N. Vassiljeva, Fungal Diversity 17: 193 (2004) Fig. 1

Stromata erumpent through the bark, widely effused, flat, about 1 mm thick, chocolate colored, with shallow discoid or ring-like ostioles scattered at the surface, without a black stromatic zone in the substrate. Perithecia in one or two layers, globose, 200–300 µm diam. Asci clavate, p. sp. 30–40 × 4–6 µm, with short stalks, apical ring J-positive. Ascospores hyaline, slightly curved, (6–)7–9(–10) µm long.

Specimens examined: Arkansas, Ozark Mountains, Ozark Science Center, 22.VI.2006, VLA P-2106; Texas, Big Thicket National Preserve: Big Sandy Creek Unit (Beaver Slide Trail), 2.VIII.2007, VLA P-2111; Loblolly Unit, 3.VIII.2007, VLA P-2112; Turkey Creek Unit (Turkey Creek Trail and Kirby National Trail), 4.VIII.2007, VLA P-2113 and 11.VIII.2007, VLA P-2114; all specimens occurred on dead branches of *Quercus* spp.

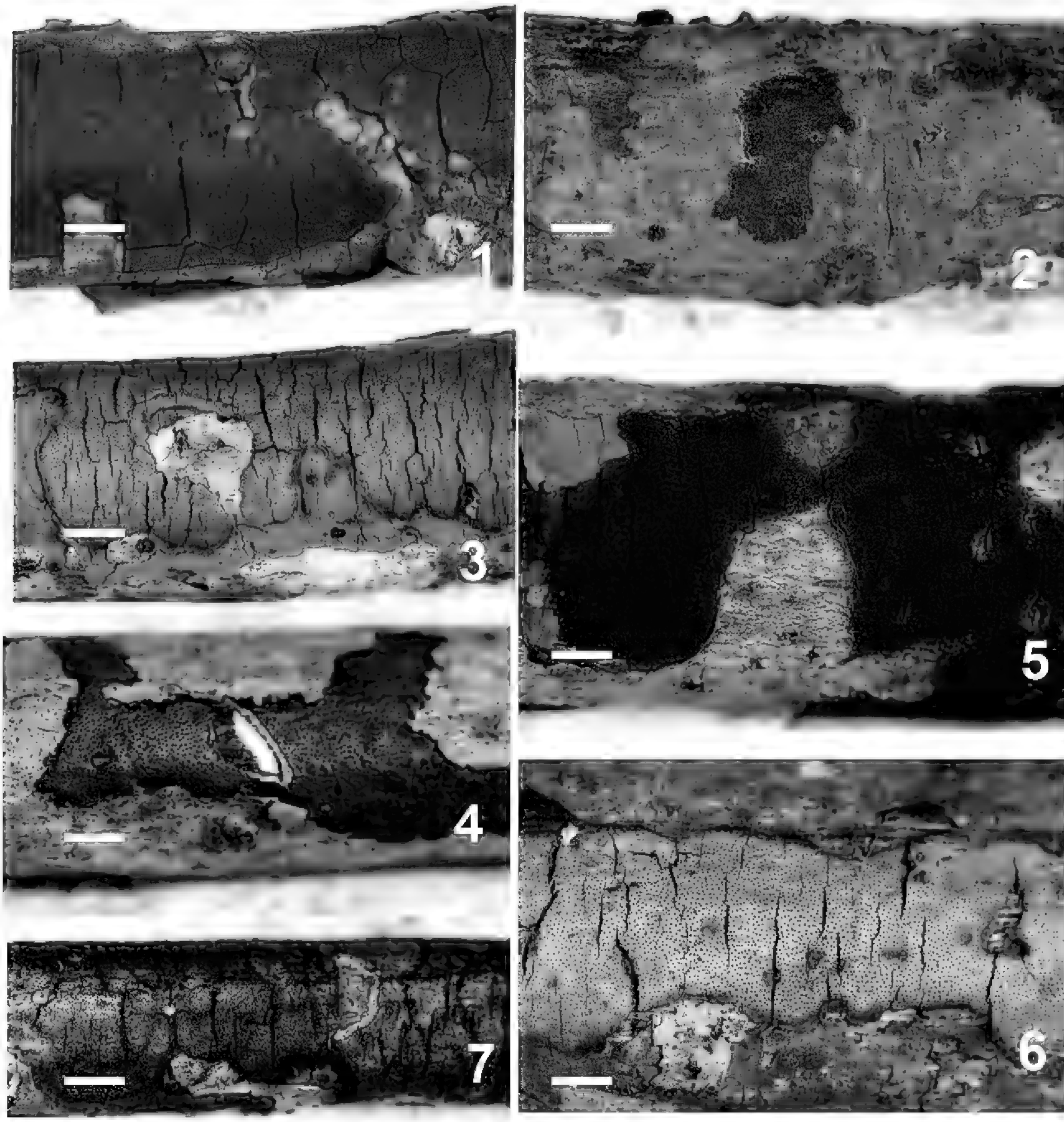
Diatrype caryae Lar.N. Vassiljeva & S.L. Stephenson, **sp. nov.** Figs 2, 11

MycoBank MB 512376

Stromata e cortice erumpentia, applanata, circiter 1 mm crassa, late effusa, 'maculae' irregulares fertiles nigrae cum ostioli vadosi discoidei vel punctiformi superficie dispersi et textum sterile cingens pallide brunneum composita. Entostroma atra, perithecia 200–300 µm diam. mono- vel disticha continens, sine zona nigra sub stromatibus. Asci oblongo-saccati, angusti, octospori, p. sp. 28–33 × 4–5 µm, breviter stipitati vel paene sessiles, fascicli minuti formanti, annulo apicali in liquore iodato Melzeri haud cyanescente. Ascosporae hyalinae, rectae vel leviter curvatae, 5–7 µm longae.

Holotype: USA, Texas, Big Thicket Natural Preserve, Turkey Creek Unit, Turkey Creek Trail, on dead branches of *Carya tomentosa* (Poir.) Nutt., 13.VIII.2007, leg. Larissa N. Vasilyeva (VLA P-2115).

Etymology: refers to the genus (*Carya*) of the host plants.



Figs 1–7. Surface of the stromata: 1 - *Diatrype atlantica*, 2 - *Diatrype caryae*, 3 - *Diatrype decorticata*, 4 - *Diatrype ilicina*, 5 - *Diatrype platystoma*, 6 - *Diatrype stigma*, 7 - *Diatrype stigmaoides*.
Scale bars. 1–4 = 4 mm, 5–6 = 2.7 mm, 7 = 3.5 mm.

Stromata erumpent through the bark, flat, about 0.5 mm thick, widely effused and consisting of irregular black fertile patches with shallow discoid or punctiform ostioles scattered at the surface and surrounded by light brown sterile tissue. Entostroma dark with embedded perithecia, these 200–300 μm diam. in one or two layers, without a black stromatic zone beneath stromata. Asci oblong-saccate, narrow, eight-spored, p. sp. 28–33 × 4–5 μm, J-negative, with short stalks, almost sessile in small fascicles. Ascospores hyaline, straight or very slightly curved, 5–7 μm long.

Additional specimens examined: Arkansas, Ozark Mountains, Ozark Science Center, dead branches of *Carya cordiformis* (Wangenh.) Nutt., 21.VI.2006, VLA P-2046; Florida,

Gainesville, bark of *Carya* sp. [Ravenel's Fungi Americani Exsiccati N 359: "*Diatrype stigma*"].

Comments: This species is similar to *Diatrype atlantica* and *D. hypoxyloides* De Not. in having non-sulcate ostioles, but it differs from both of them in having very thin stromata that possess a characteristic coloration of black fertile parts and light brown sterile ones. The epithet 'bicolor' could be applied to them as the species name, but it has already been used for another taxonomic entity (*Diatrype bicolor:* type specimen, K 154358) which has quite a different stromatal habit.

Ravenel's specimen of "*Diatrype stigma*" (Fungi Amer. Exs. N 359) consists of two species (*D. atlantica* on *Quercus* sp. and *D. caryae* on *Carya* sp.).

Diatrype decorticata (Pers.) Rappaz, Mycol. Helvetica 2: 398 (1987) Fig. 3

Stromata erumpent through the bark, irregular, widely effused, pallid-brown or brown, about 0.5 mm thick, with a dark stromatic zone surrounding them. Perithecia in one or two layers, globose, 200–300 µm diam., with sulcate ostioles. Asci clavate, p. sp. 30–40 × 4–6 µm, J-positive, with long stalks up to 35–40 µm long. Ascospores hyaline, allantoid, 6–8 µm long.

Specimens examined: Texas, Big Thicket National Preserve: Big Sandy Creek Unit, (Beaver Slide Trail), 2.VIII.2007, VLA P-2116; Beech Creek Unit (Beech Woods Trail), 9.VIII.2007, VLA P-2117; both specimens on dead branches of *Fagus grandifolia.*

Diatrype ilicina Lar.N. Vassiljeva & S.L. Stephenson, **sp. nov.** Figs 4, 8

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Stromata e cortice erumpentia in modum placae irregulares stratum extimum cortiale laceratum tenuissimum cirumdatae, late effusa, circiter 1 mm crassa, superficie pallide vel atro brunnea, interdum griseola, cum ostiola depresso stellata. Entostroma alba, perithecia globosa 300–400 µm diam. monodisticha continens, linea nigra margine circumdata. Asci oblongo-saccati, octospori, p. sp. 25–35× 4–6 µm, stipite circiter 15–20 µm suffulti, annulo apicali in liquore iodato Melzeri haud cyanescente. Ascosporae hyalinae, allantoideae, 5–7 µm longae.

Holotype: USA, Texas, Big Thicket Natural Preserve, Lance Rosier Unit, Teel Road, on dead branches of *Ilex vomitoria* Aiton, 6.VIII.2007, leg. Larissa N. Vasilyeva (VLA P-2118).

Etymology: refers to the genus (*Ilex*) of the host plants.

Stromata erumpent through the bark as irregular plates surrounded by scraps of the very thin outermost bark layer, widely effused, about 1 mm thick, surface light to dark brownish or grayish, with low stellate ostioles. Entostroma white with embedded globose perithecia 300–400 µm diam. in one layer, delimited by a thin black line at the margins. Asci oblong-saccate, eight-spored, p. sp. 25–35 × 4–6 µm, J-negative, with stalks about 15–20 µm long. Ascospores hyaline, allantoid, 5–7 µm long.

Additional specimen examined: Arkansas, Ouachita Mountains, Ouachita Mountains Biological Station, dead branches of *Ilex vomitoria* Aiton, 27.VI.2006, VLA P-2119.

Diatrype platystoma (Schwein. : Fr.) Berk., Grevillea 4: 95 (1876) Fig. 5

Stromata erumpent through the bark, widely effused, about 1 mm thick, brown but looking like black velvet due to the tightly crowded, black and discoid ostioles at their surface, with a black stromatic zone in the substrate. Perithecia in one or two layers, globose or compressed, 300–400 μm diam. Asci narrowly-clavate, p. sp. 30–40 × 4–6 μm, J-positive, with short stalks. Ascospores hyaline, allantoid, (5–)7–10 μm long.

Specimen examined: Arkansas, Ozark Mountains, Ozark Science Center, dead branches of *Ostrya virginiana,* 25.VI.2006, VLA P-2107.

Diatrype stigma (Hoffm. : Fr.) Fr., Summa Veget. Scand., p. 385, 1849 Figs 6, 9

Stromata erumpent through the bark, widely effused, about 1 mm thick, surface light brown, with stromatic columns extending into the substrate (as could be seen at the Fig. 9). Perithecia in one or two layers, globose or compressed, 300–500 μm diam., with sulcate ostioles. Asci clavate, p. sp. 30–45 × 5–6 μm, J-positive, with long stalks up to 50–60 μm. Ascospores yellowish, allantoid, 6–10 μm long.

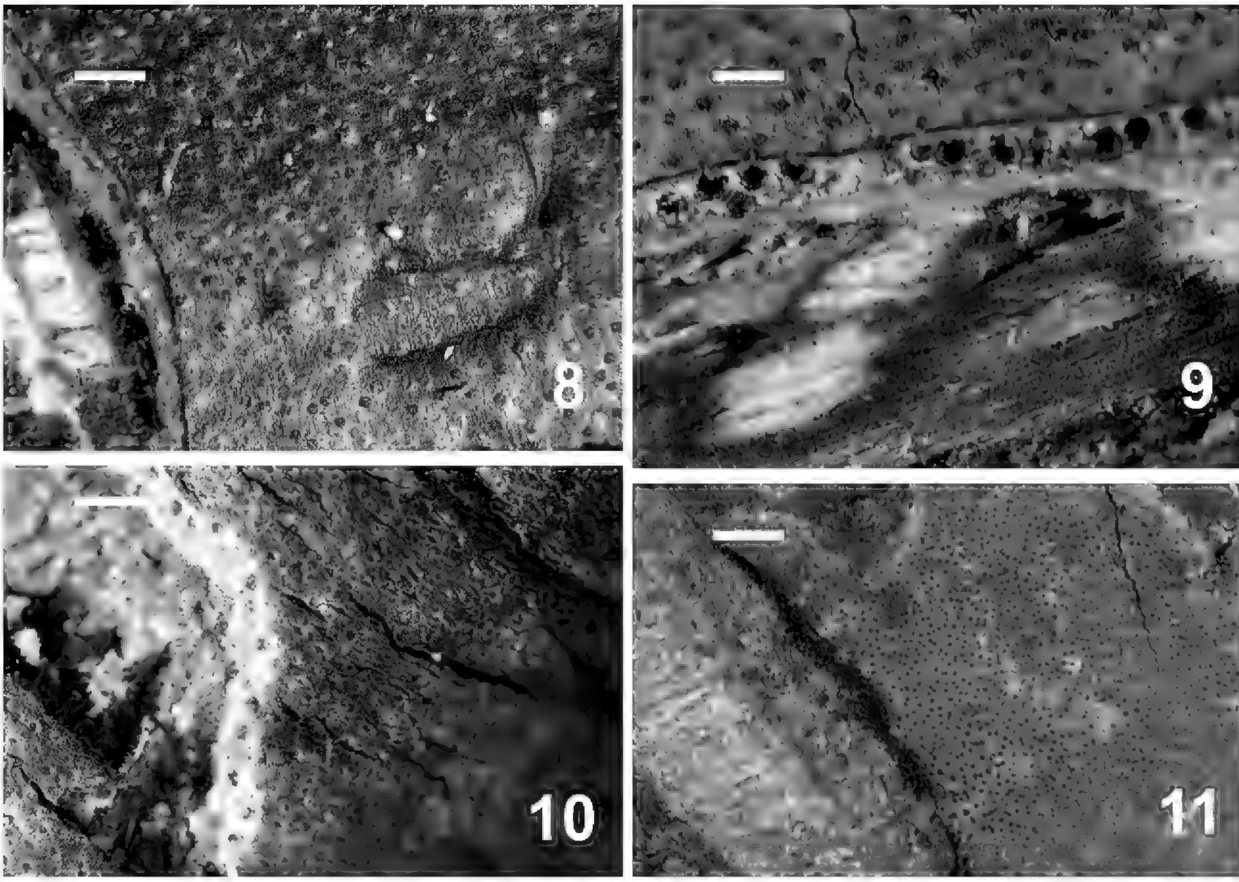
Specimens examined: USA, Arkansas, Ozark Mountains, Ozark Science Center, dead branches of *Carya cordiformis,* 21.VI.2006, VLA P-2108; Ouachita Mountains, Ouachita Mountains Biological Station, dead branches of *Ostrya virginiana,* 25.VI.2006, VLA P-2109; Texas, Big Thicket National Preserve, Turkey Creek Unit, Turkey Creek Trail, dead branches of *Carya* sp., 4.VIII.2007, VLA P-2120.

Comments: This species was also found on *Carya* sp. in the Great Smoky Mountain National Park (Tennessee, Rainbow Falls Trail), but this was not indicated in our previous paper (Vasilyeva & Stephenson 2004).

Diatrype stigmaoides Kauffman, Pap. Michigan Acad. Sci. Art. Lett., 11: 165, 1930 Figs 7, 10

Stromata erumpent through the bark, widely effused, about 0.5–1 mm thick, whitish within, surface grey or dark-grey with a slight luster, without stromatic zone in the substrate. Perithecia in one layer, globose, 400–450 μm diam., with faintly sulcate ostioles. Asci clavate, p. sp. 20–30 × 5–6 μm, J-positive, with long stalks up to 60–70 μm. Ascospores hyaline, allantoid, 4–6 μm long.

Specimens examined: USA, Arkansas, Ozark Mountains, Ozark Science Center, 19.VI.2006, VLA P-2055; Ouachita Mountains, Ouachita Mountains Biological Station, 23.VI.2006 VLA P-2110; Texas, Big Thicket National Preserve, Loblolly Unit, 3.VIII.2007, VLA P-2121; Lance Rosier Unit (Teel Road), 6.VIII.2007, VLA P-2122; Turkey Creek Unit (Kirby National Trail), 11.VIII.2007, VLA P-2123, with all collections on *Quercus* spp.



Figs 8–11. Sections of the stromata: 8 - *Diatrype ilicina,* 9 - *Diatrype stigma,* 10 - *Diatrype stigmaoides,* 11 - *Diatrype caryae.* Scale bars = 0.6 mm.

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Termitomyces striatus f. *pileatus* f. nov. and f. *brunneus* f. nov. from Cameroon with a key to central African species

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Abstract – Two new forms of *Termitomyces striatus* are described from Cameroon and a preliminary key to the central African taxa is provided for the first time. *T. striatus* f. *pileatus* is characterized by an often subinfundibuliform pileus that is usually squamulose greyish orange when young and cocoa brown or leather brown in age. This new form is additionally characterized by an obtuse to obtusely conical perforatorium, more or less conspicuously radially striate mature pileus, inconspicuous annulus present only on young basidiomes, a long filiform pseudorhiza, and polymorphic pleuro- and cheilocystidia. *T. striatus* f. *brunneus* is distinguished by a plicate- to sulcate- striate unchanging chocolate brown to dark brown pileus with a conspicuous mammiform perforatorium made of erect subcylindrical and inflated chains of cells; this form is further distinguished by polymorphic cystidia that differ from those found in *T. striatus* f. *pileatus*.

Key words – *Basidiomycetes*, *Tricholomataceae*, termite symbionts, taxonomy

Introduction

The genus *Termitomyces* R. Heim includes a group of paleotropical and good edible *Agaricales* sharing some common ecological and morphological features, of which the most conspicuous are the obligate symbiotic association with termites belonging to the subfamily *Macrotermitinae*, the presence of a more or

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less conspicuous umbo (called a 'perforatorium') that is pointed in some species and believed to help the basidiome forge its way out of the soil during growth and the presence of a pseudorhiza, a thread-like subterranean elongation of the stipe connected to combs built by termites in giant or subterranean termite nests.

Since Heim (1942) erected this genus with 10 species and 6 forms, several other taxa have been described or reported by several authors, mainly from Africa and Asia (Alasoadura 1966; Heim 1951, 1952, 1958, 1977; Mossebo et al. 2002; Natarajan 1979; Otieno 1964; Pegler 1977; Pegler & Vanhaecke 1994; Piearce 1987; Saarimäki et al. 1994; Tang et al. 2005, 2006; Turnbull & Watling 1999; Van der Westhuizen & Eicker 1999; Wei et al. 2004; Zoberi 1972). Kirk et al. (2001), who refer the genus to the *Tricholomataceae* R. Heim ex Pouzar, estimate that about 40 *Termitomyces* species have so far been described worldwide. The majority of species is restricted to tropical Africa, which together with parts of Asia are the only regions of the world where this genus grows. Aanen et al. (2002) showed that symbiosis between these fungi and termites has a single African origin, while Frøslev et al. (2003) demonstrated a phylogenetic differentiation between African and Asian samples.

No doubt, several other taxa of *Termitomyces* remain undescribed in tropical Africa, especially in still uninvestigated large areas of tropical rain forests and savannahs. In one recent contribution that expanded knowledge of African species, Mossebo et al. (2002) documented 14 records of *Termitomyces* from Cameroon that included four new species and four new forms, namely *Termitomyces griseiumbo* Mossebo, *T. subumkowaan* Mossebo, *T. mboudaeina* Mossebo, *T. subclypeatus* Mossebo, *T. subclypeatus* f. *tetrasporus* Mossebo, *T striatus* f. *subumbonatus* Mossebo, *T. striatus* f. *bibasidiatus* Mossebo and *T. striatus* f. *griseiumboides* Mossebo. Since that time, other collections have been obtained in Cameroon and central Africa (some belonging to the *T. striatus* group) with striking morphological features not matching any previously described taxa. Therefore, here we describe *Termitomyces striatus* f. *pileatus* and f. *brunneus* as two new forms of this species. We also present a first preliminary key to the most common taxa of *Termitomyces* from the central Africa region as well as a key to the known (according to 'Index Fungorum:' www.indexfungorum.org) and two newly described forms in the *T. striatus* group.

Materials and methods

Taxon sampling

Samples of the two new forms of *T. striatus* collected and described in Cameroon were compared with herbarium material curated in the Mycology Section, Royal Botanic Gardens in Kew, where voucher specimens were

deposited and encoded in the mycological herbarium. The more than 30 specimens investigated represented most of the well-established taxa (Kirk et al. 2001) of *Termitomyces* worldwide. Voucher specimens are deposited in the herbarium of Mycological Laboratory, University of Yaoundé 1 – HUYI, and in the mycological herbarium of the Royal Botanic Gardens, Kew – K(M).

Morphology

Colours were described according to Kornerup & Wanscher (1978) and samples identified using among others the publications cited in References. For microscopic features, sections were prepared from fresh or dried materials using a razor blade and mounted in 5% KOH (for exsiccata) before staining with phloxine B or ammoniacal congo red and examined with an Olympus CH2 microscope; drawings were made from the attached camera lucida. Dimensions of basidiospores, basidia, cystidia, lamellar hyphae, pileipellis elements, and other features were measured using an ocular micrometer. Basidiospore, basidia, and cystidia morphologies were described following Berger (1980). At least 20 basidiospores were measured for each taxon collected and the following parameters calculated: Q = L/W, where Q is the ratio of the length (L) over the width (W) and Q_R, the arithmetic mean value of Q. Mean values of L and W are given in italics and their extreme values in brackets.

Taxonomic description

Termitomyces striatus* f. *pileatus Mossebo **f. nov.** FIGS. 1 & 3

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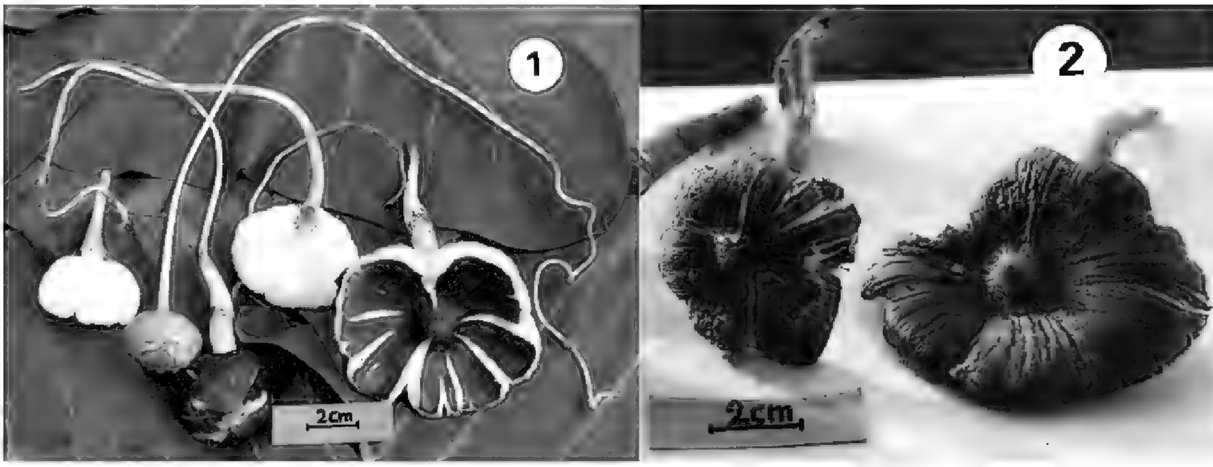
Pileus 2–3.5 cm diametro in status juvenis, primo hemisphaericus vel convexus, aurantiacus-cinerascens atque squamulosus, dein 4–8 cm diametro ubi fungus maturus est, saepissime subinfundibiliformis, vetus cacainus vel cinereus-brunneolus atque non squamulosus. Lamellae 0.3–0.9 cm latae, liberae, ventricosae, confertae, albidae. Stipes 2–6 × 0.6–1 cm, solidus, glaber, subalbidus vel cinerascens, contextus stipitis pallide subroseus et pseudorhiza filiformis longa. Annulus non conspicus in juvenis sporocarpia vel absentia in fungus maturus. Caro alba, fere 14 mm spissa. Sporarum depositum albidum. Basidiosporae 4.5–5.7–6.0(–8.0) × 2.6–3.1–3.5 µm, ellipsoideae, subellipticae vel subcylindraceae, tenui tunica. Basidia 14–22× 5–9 µm, clavata, 4-sporigera. Cheilocystidia 20–45× 9–17 µm, multiformia, clavata, utriformia, lageniformia vel capitata, subcylindracea. Pleurocystidia 25–45 × 9–16 µm, multiformia, clavata, fusiformia, cylindracea vel subutriformia. Trama hymenophoralis regularis. Hyphae cuticulae pilei 2 cellula stratae, stratum superius cum hyphae 2–7 µm diametro, stratum inferius cum hyphae fere 25 µm diametro. Habitat in zonus termitariorum praesertim subterraneorum.

HOLOTYPUS:*AFRICA, CAMEROON, Provincia centri, vicus Toutouli, fere 20 km ab Yaoundeae, 20.XI.2002 leg. D. C. Mossebo, in Herbaria Universitatus Yaoundeae, HUYI DM 394. ISOTYPUS in Kew, K(M) 144 301.*

MACROCHARACTERS — PILEUS 2–3.5 cm diam on young basidiomes, first hemispherical to convex, surface greyish orange [5B4] on young basidiomes



Figs. 1–2. Two new forms of *Termitomyces striatus*. 1. *Termitomyces striatus* f. *pileatus* (K(M) 144 301, holotype). Basidiomes. 2. *Termitomyces striatus* f. *brunneus* (K(M) 144 300, holotype). Basidiomes.

usually squamulose with tiny whitish patches around the disc; 4–8 cm diam on mature subjects changing to cocoa brown or leather brown [6E6] to brownish grey [6F8], mostly subinfundibuliform with a more conspicuous and usually obtuse to obtusely conical perforatorium, sometimes radially and deeply incised at various lengths showing the contrasting white context; Lamellae 0.3–0.9 cm wide, free, ventricose, white, crowded with numerous lamellulae of various dimensions; Stipe 2–6 × 0.6–1 cm, solid, central, glabrous, whitish to slightly greyish with section surface becoming slightly pinkish, subcylindrical on its upper part and gradually tapering to form a long underground filiform pseudorhiza up to 60 cm long; Annulus born on partial veil, inconspicuous on young basidiocarps, rare or absent on mature; Context white, up to 1.4 cm thick at stipe level consisting of inflated thin-walled hyphae, 25 µm diam; Odour none; Spore deposit whitish; Type of growth isolated or in small groups.

Microcharacters — Basidiospores 4.5–*5.7*–6.0(8.0) × 2.6–*3.1*–3.5 µm, Q=1.5–2.3, Q_R=1.8 ± 0.2, N=20, ellipsoidal to subelliptic, sometimes subcylindrical, hyaline, granulate, thin-walled; Basidia 14–22 × 5–9 µm, clavate, hyaline, bearing 4 sterigmata; Pleurocystidia 25–45 × 9–16 µm, clavate, fusiform, subcylindrical or subutriform, thin-walled; Cheilocystidia 20–45 × 9–17 µm, polymorphic, clavate to largely clavate, utriform, sublecythiform to capitate, subcylindrical; hyaline, thin-walled; Hymenophoral trama regular, comprising unclamped hyphae up to 25 µm diam; Subhymenial layer made of pseudoparenchymatous cells up to 30 µm diam; Pileipellis composed of 2 layers of cells, upper layer of repent unclamped thin-walled hyphae, 2–7 µm diam, lower layer made up of inflated hyphae up to 25 µm diam; Longitudinal section of the perforatorium shows erect chains of subcylindrical thin-walled cells measuring 5 µm diam with some scattered laticeferous hyphae.

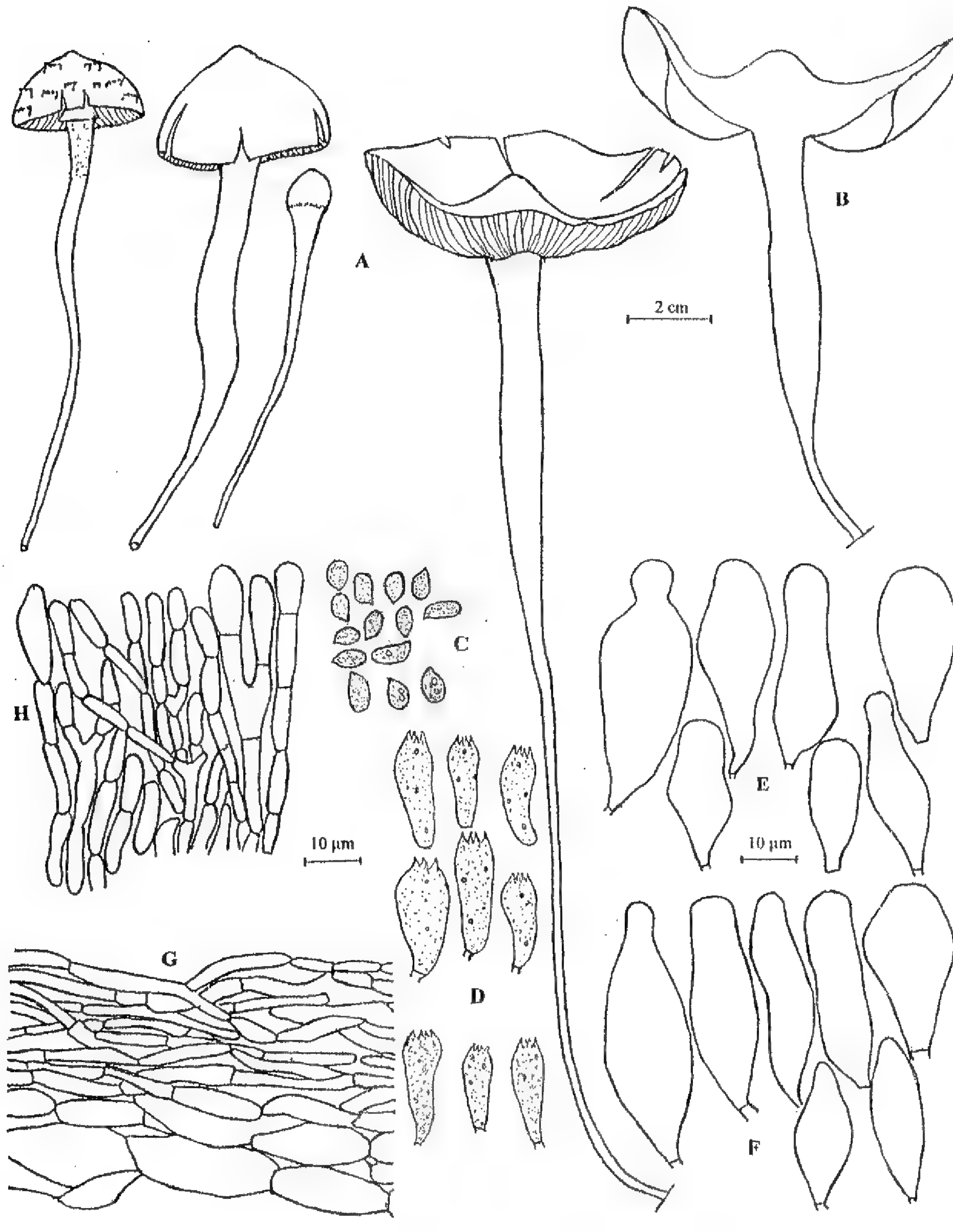


Fig. 3. *Termitomyces striatus* f. *pileatus* (K(M) 144 301, holotype).
(A) habit; (B) longitudinal section of (A); (C) basidiospores; (D) basidia; (E) cheilocystidia; (F) pleurocystidia; (G) pileipellis; (H) longitudinal section of the perforatorium.

Ecology, habitat, distribution — known only from the type locality in Cameroon; growing on subterraneous termitarium in forestry area.

Specimens examined – **CAMEROON**. **Centre Province**, about 20 km from the capital **Yaoundé**, Toutouli village, Odza quarter, in a secondary forest, 20 Nov. 2002, leg. D.C. Mossebo; Holotype: HUYI DM 394; Isotype: K(M) 144 301.

Termitomyces striatus* f. *brunneus Mossebo **f. nov.** FIGS. 2 & 4

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Pileus 4.5–8.5 cm diam, convexus vel planoconvexus cum perforatorio conspicuo mammiformi, cinereus-brunneolus vel atrobrunneus, striatus. Lamellae liberae, confertae, leviter ventricosae ad 1 cm latae, albidae vel rosaceae. Stipes 10–12.5 × 0.5–1 cm, solidus, cylindraceus, glaber, albidus, basi cum pseudorrhiza albida ; annulus nullus. Caro albida. Basidia 15–26 × 5–7 µm, clavata vel subcylindracea, 4-sporigera. Basidiosporae 4–5.1–6.0(–8.0) × 2.4–3.1–4 µm, ellipsoideae vel subellipsoidae. Cheilocystidia 20–35 × 7–18 µm, piriformia vel clavata, subcylindracea, aliquando rostrata. Pleurocystidia 25–50 × 8–18 µm, lageniformia vel subcylindracea, subfusiformia. Trama hymenophoralis subregularis. Hyphae cuticulae pilei in 2 cellula stratae, stratum superius cum 2–5 µm diam protratus hyphae, stratum inferius cum 10–30 µm diam catenuliformis prostratus hyphae. Habitat in zonus termitariorum praesertim subterraneorum.

HOLOTYPUS: *AFRICA, CAMEROON, Provincia meridianus, Sangmelima, fere 160 km ab Yaoundeae, 3.XI.2002, leg. D. C. Mossebo, in Herbaria Universitatus Yaoundeae, HUYI DM 392. ISOTYPUS in Kew, K(M) 144 300.*

MACROCHARACTERS — PILEUS 4.5–8.5 cm diam, convex to plano-convex with a conspicuous nipple-shaped perforatorium measuring 0.5–0.7 cm in diameter and 0.5–1 cm high, more or less concolorous to the chocolate, cocoa brown, brownish grey [6F8] to dark brown [7F8] pileus, radially plicate- to sulcate striate, sometimes marginally to radially incised; LAMELLAE slightly ventricose, free, up to 1cm wide, whitish to pinkish at maturity, crowded with lamellulae of various dimensions, edge entire; STIPE 10–12.5 × 0.5–1 cm, solid, subcylindrical on its upper part and tapering at the base to form the pseudorhiza; surface whitish, glabrous; ANNULUS absent; CONTEXT white, 0.5–1 cm thick at stipe junction, comprising thin-walled hyphae, 3–15 µm diam; ODOUR none; TYPE OF GROWTH isolated or in small groups.

MICROCHARACTERS — BASIDIOSPORES 4–*5.1*–6.0(–8.0) × 2.4–*3.1*–4 µm, Q= 1.25–2.1, Q_R=1.7 ± 0.3, N=20, ellipsoid to subelliptic, hyaline, thin-walled, granulate; BASIDIA 15–26 × 5–7 µm, clavate to subcylindric, hyaline, bearing 4 sterigmata; PLEUROCYSTIDIA 25–50 × 8–18 µm, lageniform, subcylindric, subfusiform, thin-walled; CHEILOCYSTIDIA 20–35 × 7–18 µm, pyriform to largely clavate, subcylindrical, sometimes rostrate, hyaline, thin-walled; HYMENOPHORAL TRAMA subregular, made up of hyaline hyphae, 2–15 µm diam; SUBHYMENIAL LAYER made up of pseudoparenchymatous cells up to 28–32 µm diam; PILEIPELLIS comprising 2 layers, a thin upper layer of repent hyphae measuring 2–5 µm diam and a much more thicker lower layer of equally repent hyphae in chains, 10–30 µm diam; LONGITUDINAL SECTION OF THE PERFORATORIUM showing a trichoderm made of erect, chains of subcylindrical and sometimes inflated cells 2–8 µm diam.

ECOLOGY, HABITAT, DISTRIBUTION – known only from the type locality in Cameroon, growing on a subterraneous termitarium in forestry area.

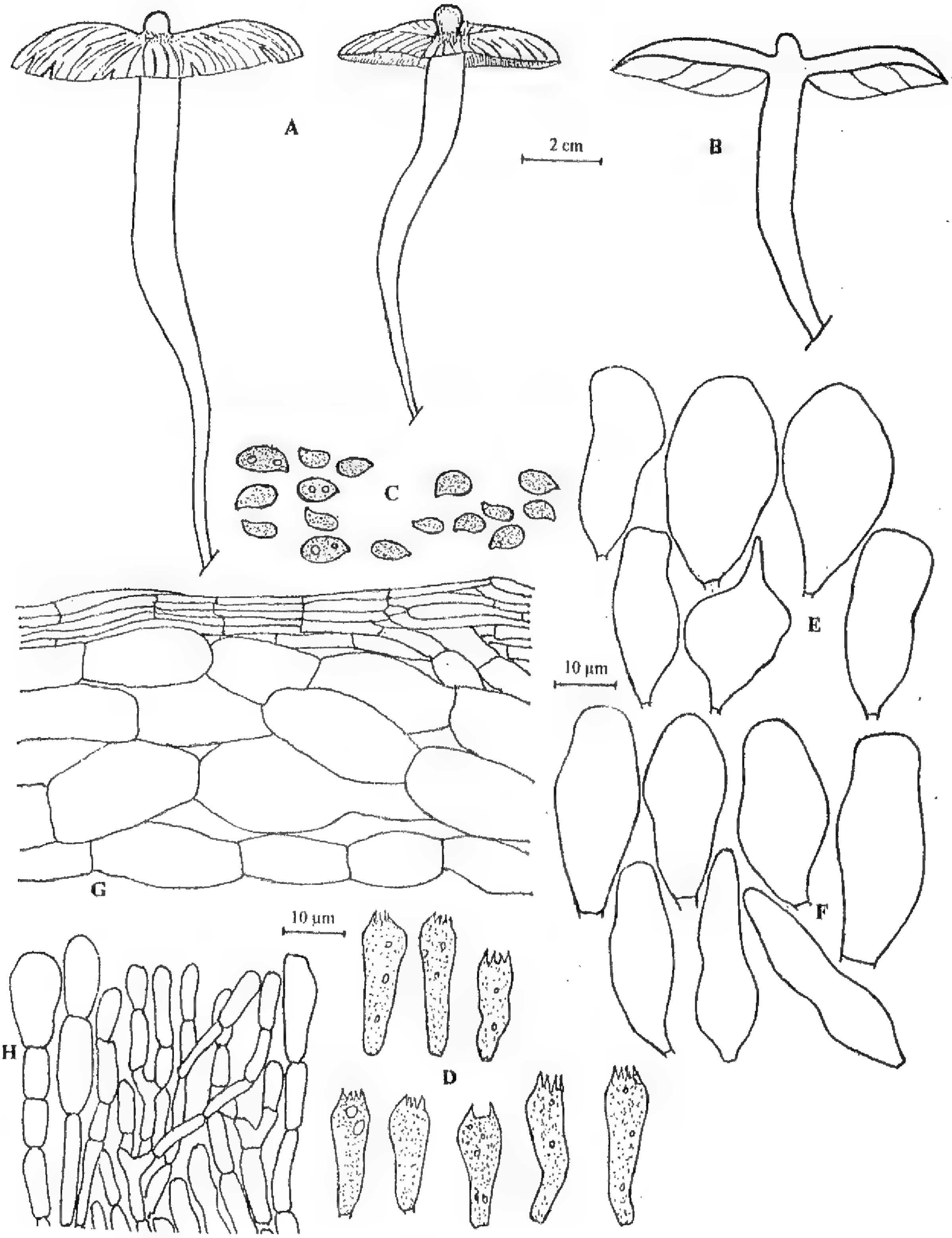

Fig. 4. *Termitomyces striatus* f. *brunneus* (K(M) 144 300, holotype).
(A) habit; (B) longitudinal section of (A); (C) basidiospores; (D) basidia; (E) cheilocystidia; (F) pleurocystidia; (G) pileipellis; (H) longitudinal section of the perforatorium.

Specimens examined – **CAMEROON.** SOUTH PROVINCE, **Sangmelima**, about 160 km south of the capital Yaoundé, surface ground of a subterraneous termitarium, 3 Nov. 2002, leg. D.C. Mossebo; Holotype: HUYI DM 392; Isotype: K(M) 144 300.

Forms in *Termitomyces striatus*

Heim (1942) introduced forms in *Termitomyces striatus* (Beeli) R. Heim when he described *T. striatus* f. *striatus* (Beeli) R. Heim, which he also treated as a variety (*T. striatus* var. *striatus* (Beeli) R. Heim) in the *T. striatus* group (Heim 1942). Likewise, Heim later (1958) lowered his *T. striatus* var. *annulatus* R. Heim (Heim 1942) to forma as *T. striatus* f. *annulatus* (R. Heim) R. Heim. The same author (Heim 1958) also described two additional forms, *T. striatus* f. *griseus* R. Heim and *T. striatus* f. *ochraceus* R. Heim. These forms are mainly distinguished from each other by the remarkable and variable type of striation of the pileus rarely exceeding 8.5 to 12 cm diam at full maturity and usually more or less densely and radially striate, its colouration, the presence or absence of an annulus and its upwards or downwards orientation, and the morphology of the perforatorium. Other *Termitomyces* species differ from *T. striatus* mainly by the lack of this remarkable pileus striation and other features noted by various authors (Heim 1942, 1952, 1958, 1977; Pegler 1977; Piearce 1987; Van der Westhuizen & Eicker 1999). Heim (1977) later elevated *T. striatus* var. *aurantiacus* R. Heim originally characterised by a bright orange to reddish ochraceous pileus (Heim 1952) to species as *T. aurantiacus* (R. Heim) R. Heim.

The first preliminary keys within the *T. striatus* group were introduced by Heim (1977) and Pegler (1977), both of whom included three formae — f. *annulatus*, f. *griseus* and f. *ochraceus* — in their respective keys. However, Pegler (1977) retained the varieties *T. striatus* var. *aurantiacus* R. Heim and *T. striatus* var. *striatus* (Beeli) R. Heim in his key, while Heim (1977) assigned *T. aurantiacus* (R. Heim) R. Heim and *T. entomoloïdes* R. Heim to the *T. striatus* group. A key to the forms of *Termitomyces striatus* now cited on Index Fungorum (www.indexfungorum.org) with the addition of the two newly described forms and *T. striatus* f. *annulatus* (R. Heim) R. Heim described by Heim (1958) follows.

Preliminary key to the forms of *Termitomyces striatus*

(Revised and augmented from Heim (1977) and Pegler (1977))

1a. Mature pileus up to 12 cm diam or more, marginally or radially striate, sometimes incised, whitish, beige to ochraceous or greyish, ... 2

1b. Mature pileus smaller, rarely up to 8.5 cm diam, variously striate or incised with different colourations (not orange or fox-coloured) 6

2a (1a). Annulus absent 4

2b. Annulus persistent and conspicuous or with membranous inconspicuous squamules on stipe 3

3a (2b). Pileus sometimes above 12 cm diam, whitish on surface, brownish around the disc showing tiny concolorous squamules, perforatorium

conical to subcylindric-mammiform, concolorous with pileus surface; annulus conspicuous, persistent and downwards oriented .... ***T. striatus* f. *annulatus***

3b. Pileus not exceeding 12 cm diam, surface greyish brown, ochraceous brown to ochraceous orange, darkish at the centre, perforatorium ± conspicuous, annulus inconspicuous or as membranous squamules on stipe .... ***T. striatus* f. *striatus***

4a (2a). Pileus beige to greyish or dark to greyish-dark 5

4b. Pileus cream to ochraceous brown .... ***T. striatus* f. *ochraceus***

5a (4a). Hymenium showing 2 types of basidia: thin-walled (18–19 × 6.5–8 μm), rare, 4-sterigmate basidia; thick-walled (19–22 × 6–7 μm), abundant, with 1–4-sterigmate basidia; cheilo- and pleurocystidia similar, sometimes with median constrictions .... ***T. striatus* f. *bibasidiatus***

5b. Hymenium with only one type of basidia: thin-walled (22–25 × 7–8 μm), clavate, with 4 sterigmata .... ***T. striatus* f. *griseus***

6a (1b). Stipe with a swelling at the base before tapering to form pseudorhiza, pileus 2.5–5 cm at maturity, beige-greyish to greyish-dark with a contrasting grey-blackish perforatorium .... ***T. striatus* f. *griseiumboides***

6b. Stipe showing no swelling at the base, rather ± subcylindrical above the pseudorhiza 7

7a (6b). Perforatorium conspicuous, obtuse to subcylindrical or mammiform (nipple-shaped)...8

7b. Perforatorium inconspicuous, subumbonate with a greyish brown to violaceous brown umbo showing tiny squamules, pileus whitish to pale greyish, pileipellis made of erect septate and gelified hyphae 5–8 μm diam .... ***T. striatus* f. *subumbonatus***

8a (7a). Perforatorium nipple-shaped (mammiform), pileus uniformly and constantly chocolate brown to dark brown from origin, plicate to sulcate striate .... ***T. striatus* f. *brunneus***

8b. Perforatorium obtuse to obtusely conical, pileus changing from greyish orange with squamules when young, to cocoa brown or leather brown when mature, glabrous and usually subinfundibiliform at maturity .... ***T. striatus* f. *pileatus***

The above-mentioned forms of *T. striatus* (Beeli) R. Heim are variously distributed in whole Africa south of Sahara. They are found in most central African countries including Cameroon, Central African Republic, Gabun, Congo Brazzaville, Congo DRC, Burundi, and Rwanda. *Termitomyces striatus* (Beeli) R. Heim, and particularly its form *striatus,* is also reported in several Asian countries including China, India, Thailand, Pakistan, and Malaysia.

Additional specimens examined – **Cameroon**: 1) *T. striatus* f. *subumbonatus*: Yaoundé, Centre Province, university of Yaoundé 1 campus, Oct. 1998, D.C. Mossebo DM 208 (K(M) 144294); 2) *T. striatus* f. *annulatus*: Yaoundé, Nov. 2002, D.C. Mossebo DM 213 (K(M) 144286); 3) *T. striatus* f. *bibasidiatus*: near Yaoundé, purchased in Mokolo

mushroom market, Oct. 2000, D.C. Mossebo DM 280 (K(M) 144292); 4) *T. striatus* f. *griseiumboides*: near Yaoundé, May 2001, D.C. Mossebo DM 372 (K(M) 144288); 5) *T. griseiumbo*: Yaoundé, Mokolo mushroom market, May 1999, D.C. Mossebo DM 224 (K(M) 143970). **Central African Republic:** 6) *T. medius* R. Heim & Grassé: Bangui mushroom market, 29 August 2008, M. Djamndo Djasbé DSB 036 (DM 687); 7) *T. striatus* f. *annulatus*: Bangui mushroom market, 29 August 2008, M. Djamndo Djasbé DSB 037 (DM 688); **Congo**: 8) *T. striatus* f. *striatus*: mushroom market about 4 km in the outskirts of Brazzaville, Sept. 2008, N. Nkouka, NNK 01 (DM 689). GABUN: 9) *T. striatus* f. *annulatus*: in a banana plantation about 10 km in the outskirts of Libreville, Oct. 2008, Obam Moundoundou OMD 01 (DM 690). **Nigeria:** 10) *T. striatus*: Cross River State, Uyo, Anua, St Luke's Hospital, May 1990, R.A. Nicholson 431 (K(M) 16687); 11) *T. clypeatus*: Zaria, Ahmadu Bello University, July 1994, P. Mwarze (K(M) 117359). **Ghana:** 12) *Termitomyces* sp: Cape Coast, University College, May 1971, A.C. Rose, CC7109 (K(M) 109563). UGANDA: 13) *T. robustus*: Kampala, purchased in the market, March 1957, A. French 7 (K(M) 109 570). **Kenya:** 14) *Termitomyces* sp.: Malindi, Robertson Plot, Coast Province, April 1997, S.A. Robertson 7241 (KM 77539); 15) *T. striatus*: Naïrobi, City Park, April 1968, D.N. Pegler K375 (K(M) 109535). **Malawi:** 16) *T. robustus*: Blantyre, Limke, Nov. 1972, C. Anthony 2 (K(M) 109569); 17) *T. striatus*: Lilongwe, Bunda College, Dec 1973, D.J. Allen 1 (K(M) 142 436). **Zambia:** 18) *T. reticulatus* Van der West. & Eicker: North Luangwa National Park, Dec. 1994, D. Shah-Smith 57 (K(M) 29129); 19) *T. titanicus* Pegler & Piearce: Kitwe and Ndola (between), Copperbelt Province, purchased by road side, Dec. 1978, G.D. Piaerce FP536 (K(M) 142 416). **South Africa:** 20) *T. reticulatus*: Pretoria, Brummeria, National Botanic Gardens, Nov. 1986, G.C.A. v.d. Westhuizen 226 (K(M) 109564); 21) *T. cartilagineus* (Berk.) R. Heim: Pretoria, Arcadia Park, (K(M) 109565). **Tanzania:** 22) *T. mammiformis* f. *albus* R. Heim: Kisimbani, July 1962, H. Faulkner 3076 (K(M) 109542); 23) *T. eurhizus* (Berk.) R. Heim: Isanga District, Lugoda Tea Estate, May 1968, D.N. Pegler T835 (K(M) 142418).

Comments — Considering the taxa of *Termitomyces* so far described, the closest species to *T. striatus* f. *brunneus* and f. *pileatus* are *T. robustus* (Beeli) R. Heim and *T. fuliginosus* R. Heim as far as the pileus features in particular are concerned. However, the essentially similar dark brown to cocoa brown pileus in these four taxa can be differentiated by various tints and ornamentations and size, the major difference being one of size, where the pileus diameter of the two newly described *T. striatus* forms rarely exceeds 8.5 cm at full maturity, whereas that of *T. robustus* and *T. fuliginosus* can each measure up to 16.5 or 20 cm diam or more (Heim 1977, Pegler 1977).

Similarly, whereas mature representatives of both *T. striatus* f. *brunneus* and *T. striatus* f. *pileatus* show an almost uniformly coloured pileus, *T. robustus* is remarkably darker or blackish at the disc and perforatorium. The perforatorium in *T. robustus* and *T. striatus* f. *brunneus* is similarly mammiform to obtusely mammiform, contrasting with the obtuse to obtusely conical perforatorium found in *T. striatus* f. *pileatus* and *T. fuliginosus*.

Termitomyces robustus also differs by its dark umber venate and scrobiculate pileus revealed by concentric irregular and radial ridges and finely tuberculate

patches on the surface. This species is also singularly distinguished by the presence of interwoven white rhizomorphic threads between the pseudorhiza and termitarium comb. Heim (1977) reports that this rhizomorphic type is found only in *T. robustus*. *T. fuliginosus* is characterized by a remarkable pileus surface ornamentation consisting of dense whitish radial striations of various lengths overlying a brownish to chocolate background. Contrary to the rhizomorphs found in *T. robustus*, *T. fuliginosus* is diagnosed by a sclerotized basal disc at the pseudorhizal base.

Termitomyces striatus f. *pileatus* is distinguished from the other forms and varieties of the *T. striatus* group by some remarkable features, including the subinfundibuliform and eventually more or less deeply radially striate pileus that is squamulose greyish orange when young and cocoa brown or leather brown in age, an inconspicuous and evanescent annulus that is present only on young basidiomes, the late appearing obtuse perforatorium, and long filiform pseudorhiza. Microscopically, the polymorphic nature of pleuro- and cheilocystidia are equally noteworthy.

Termitomyces striatus f. *brunneus* differs from other taxa by its unchanging plicate- to sulcate-striate chocolate brown to dark brown pileus with a conspicuous mammiform perforatorium made of erect chains of subcylindrical and inflated cells. The polymorphic pleuro- and cheilocystidia also differ slightly from those of *T. striatus* f. *pileatus.*

An on-going phylogenetic study of central African taxa of *Termitomyces* is still preliminary and additional representatives of some taxa still require sequencing. However, preliminary analyses of the very similar ITS, mtSSU- and nLSU-rDNA sequences for the two newly described forms support their placement in the same species, despite their morphological differences from the previously recognized forms.

Heim (1958) was the first to propose a key to African species based on the 13 taxa described in tropical Africa at that time. The addition of new species in different regions led to the development of national, regional or subregional keys for Asia as well as for tropical Africa. These include keys by Pegler (1994) for 14 taxa from Southeast Asia, by Piearce (1987) for 11 species from Zambia, by Van der Westhuizen and Eicker (1990) for 7 species from South Africa, by Otieno (1964; later amended by Pegler 1977) for 12 taxa from East Africa, and by Buyck (1994) for 5 species from the western part of Burundi. Given that no key for central Africa existed so far, the first preliminary key to *Termitomyces* from this region of Africa south of Sahara is proposed below with 17 taxa described by Heim (1951, 1952, 1958, 1977), Pegler (1977), Buyck (1994), Mossebo (2000, 2002), and Mossebo et al. (2002, 2006).

Preliminary key to *Termitomyces* taxa from central Africa

1a. Mature pileus generally smaller than 2.5 cm diam, pseudorhiza absent .... ***Termitomyces microcarpus***
1b. Mature pileus generally greater than 2.5 cm diam; pseudorhiza present 2

2a (1b). Annulus present 3
2b. Annulus absent 9

3a (2a). Mature pileus 2.5–10 cm diam, basidia bearing 4 to 2 (or 1) sterigmata 4
3b. Mature pileus generally larger than 10 cm diam, basidia bearing 4 sterigmata 7

4a (3a). Perforatorium generally conspicuous, more or less prominent 5
4b. Perforatorium absent or inconspicuous, resembling an umbo 8

5a (4a). Pileus beige to greyish beige or greyish orange and hemispherical to convex when young, when mature cacao brown, leather brown to brownish grey and subinfundibuliform with an obtuse perforatorium; annulus not persistent .... ***T. striatus* f. *pileatus***
5b. Pileus generally unchanging or barely changing colour and not becoming (sub-) infundibuliform till full maturity; annulus conspicuous................6

6a (5b). Pileus beige to beige ochraceous with greyish to dark grey disc; annulus more or less persistent; perforatorium originally mammiform, more or less conspicuous; cystidia with a remarkable appendix of various lengths at the base, pleurocystidia larger than cheilocystidia............ ***T. mammiformis***
6b. Pileus whitish ochraceous with an area of tiny brownish squamulae at the disc (perforatorium) and around; persistent downwards oriented annulus; perforatorium conical to subcylindric-mammiform, rarely less differentiated; cystidia barely appendiculate, pleurocystidia smaller than cheilocystidia ....***T. striatus* f. *annulatus***

7a (3b). Pileus beige to light brown or dark ochraceous, sometimes showing a darker central area around the disc on mature specimens; perforatorium subcylindrical (to mammiform), measuring up to 2 cm diam at maturity .... ***T. letestui***
7b. Pileus whitish with brownish to greyish squamulae, tur ning dark to blackish and showing concentric areas on the pileus with a 2 to 5 cm diam, central, thick and blackish plaque in place of a nonexistent real perforatorium .... ***T. schimperi***

8a (4b). Pileus with a barely apparent perforatorium (rarely absent) forming an inconspicuous umbo; usually striate or split at the margins; convex to plano-convex, whitish-greyish with an area of tiny brown greyish to brown violaceous squamulae in the middle of the pileus; annulus more or less persistent; cystidia thin-walled non-septate........................***T. striatus* f. *subumbonatus***
8b. Pileus without perforatorium besides the other characteristics described above (7b), cystidia thick-walled and most often septate .... ***T. schimperi***

9a (2b). Mature pileus 2.5–5 cm diam .... ***T. striatus* f. *griseiumboides***
9b. Mature pileus usually broader than 5 cm diam **10**
10a (9b). Perforatorium darkish or blackish, generally long and acutely spiniform .... ***T. clypeatus***
10b. Perforatorium not long, not spiniform, but differently shaped and more or less conspicuous **11**
11a (10b). Stipe of more or less regular diameter, generally without thickening at the base of the epigeous part **12**
11b. Stipe most often with a thickening at the base of the epigeous part before tapering gradually to form a pseudorhiza **16**
12a (11a). Perforatorium conical, most often obtuse to obtusely conical at maturity, sometimes pointed on young specimens, more or less conspicuous and concolorous to the pileus **13**
12b. Perforatorium mammiform to cylindraceous or rather less apparent at the disc **14**
13a (12a). Pileus most often dark beige to brown greyish and radially split; spores thin-walled; basidia predominantly with 2 sterigmata, (rarely with 4 sterigmata); pleurocystidia absent, perforatorium more or less concolorous with the pileus... ***T. subclypeatus***
13b. Pileus most often light beige (to whitish) and split at the margins; spores thick-walled; basidia bearing 4 sterigmata; pleurocystidia absent, perforatorium concolorous to the pileus .... ***T. subclypeatus* f. *tetrasporus***
14a (12b). Perforatorium mammiform to subcylindrical, generally concolorous with the pileus; basidia either thin- , or thin- and thick-walled **15**
14b. Pileus most often rugose and more or less conspicuously radially wrinkled; perforatorium 1–2.5 cm diameter, flattened at the disc (or obtusely conical), brown greyish to dark grey in strong contrast with the whitish pileus ....***T. griseiumbo***
15a (14a). Pileus chocolate to cocoa brown, brownish grey to dark brown, radially striate to sulcate striate; basidia thin-walled, clavate to subcylindric, bearing 4 sterigmata .... ***T. striatus* f. *brunneus***
15b. Pileus beige to beige ochraceous, most often splitting at the margins at maturity, basidia both thin-walled with 4 sterigmata and thick-walled with 1 to 4 sterigmata ....***T. striatus* f. *bibasidiatus***
16a (11b). Stipe bulb beige to whitish, always concolorous to the rest of the stipe ... **17**
16b. Stipe bulb blackish to black from its lower half to the pseudorhiza ....***T. subumkowaan***
17a (16a). Pileus dark grey to grey blackish around a generally short, concolorous and more or less pointed perforatorium; spores thin-walled .... ***T. mboudaeina***
17b. Pileus uniformly fox-coloured to orange brown (rarely ochraceous to brownish); perforatorium concolorous, sometimes less conspicuous in some specimens; spores more or less thick-walled ....***T. aurantiacus***

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A new record of foliicolous fungi in Turkey and a new host

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Abstract — *Deightoniella arundinacea* is reported for the first time from Turkey, on *Phragmites australis. Pseudorlaya* is reported as a new host genus for the powdery mildew species *Erysiphe heraclei.* The morphology of the two fungi is briefly described.

Key words — dematiaceous hyphomycete, leaf pathogen, *Apiaceae, Poaceae*

Introduction

Deightoniella S. Hughes is a genus of plant pathogenic dematiaceous fungal anamorphs to which eighteen species have currently been assigned. *Deightoniella arundinacea* (Corda) S. Hughes is distinguished from *Deightoniella roumeguerei* (Cavara) Constant. (another pathogen of leaf blades of *P. australis*) by its effuse, greyish, less defined disease symptoms, longer conidiophores and obpyriform conidia (Constantinescu 1983, Bán et al. 1996). *Deightoniella arundinacea* causes stunted growth of the host plants and characteristic grey colonies due to abundant sporulation (Ellis & Ellis 1997), especially in September. Weather conditions (especially precipitation) are important for its distribution. It occurs predominantly in medium quality reeds situated near the lakes (Bán et al. 2002), being widespread on *Phragmites australis* (Cav.) Steud. in the Britain, Czech Republic, Germany, Japan, Romania, Russia, Ukraine, but is a new record for Turkey. Only *Deightoniella torulosa* (Syd. & P. Syd.) M.B. Ellis on *Musa* spp. has been reported from Turkey (Ellis MB 1957).

The powdery mildew species *Erysiphe heraclei* DC. is known from a wide range of host plants belonging to the *Apiaceae* (Braun 1995) and has been reported from Turkey on *Aethusa* L., *Anethum* L., *Anthriscus* Pers., *Daucus* L., *Eryngium* L., *Falcaria* Fabr., *Heracleum* L., *Myrrhoides* Heister ex Fabr., *Scandix* L., *Tordylium* L., *Torilis* Adans., *Turgenia* Hoffm., *Zosima* Hoffm. (Bahcecioglu Z & Yıldız B 2005, Kabaktepe S & Bahcecioglu Z 2006, Bahcecioglu et al. 2006,

Karaboz I & Öner M 1982, Oran YK 1967, Tamer AU et al. 1987). This is the first report of the genus *Pseudorlaya* Murb. as a host for *Erysiphe heraclei.*

We report a second species of *Deightoniella* from Turkey and a new host of *Erysiphe heraclei.*

Materials and methods

The material for this study was collected during field trips carried out in the city Kahramanmaraş located in the southern Anatolian region of Turkey during 2000-01. The identification of the host specimens was achieved with the help of Flora of Turkey (Davis 1965-85). The parasitic microfungi concerned were identified using Braun (1995) and Ellis & Ellis (1997). The specimens are deposited at the Inonu University Herbarium (INU).

Results

Deightoniella arundinacea (Corda) S. Hughes, Mycol. Pap. 48: 29 (1952).

On *Phragmites australis* (Cav.) Steud. (Poaceae).

Turkey, Kahramanmaras, Turkoglu, Cakilli village, 550 m alt., 8 September 2000, Z. Bahcecioglu 3029 (INU).

Foliicolous, colonies dark grey to greyish olivaceous-brown. Conidiophores scattered to loosely caespitose, erect, subcylindrical, somewhat sinuous-nodulose, 40–90 × 4–9 µm, basal cell and apex often somewhat swollen, septate, brown; conidiogenous cells integrated, terminal, monoblastic, percurrent, subcylindrical to somewhat swollen. Conidia solitary, acrogenous, obpyriform, 20–50 × 10–18 µm, 1–2-septate, at first pale, later pigmented, pale to mid brown, smooth or almost so, wall thin to somewhat thickened, base with a distinct (cicatriced) hilum.

Eighteen species of *Deightoniella* have currently been assigned. *D. roumeguerei* and *D. arundinacea* on *Phragmites australis. D. roumeguerei* has been reported from France (Constantinescu O 1983). *D. arundinacea* has been reported from Britain, Czech Republic, Germany, Japan, Romania, Russia, Ukraine (Ellis MB 1957). *D. arundinacea* is first record for Turkey.

Erysiphe heraclei DC., Fl. franç. 6: 107 (1815)

On *Pseudorlaya pumila* Grande (*Apiaceae*).

Turkey, Kahramanmaras, 32 km from Kahramanmaras to Andirin, 500 m, 13 June 2001, Z. Bahcecioglu 3106 (INU).

Mycelium on stems, inflorescences and leaves, amphigenous, effuse or in patches. Conidiophores straight, foot-cell cylindrical, 20–35 × 8.5–10 µm. Chasmothecia scattered to subgregarious, 80–120 µm diam. Asci (2–)3–6(–8),

sessile or short stalked, 40–75(–85) × 30–45(–50) μm, (2–)3–5(–6)-spored, spores large, ellipsoid–ovoid, 18–30 × 10–16 μm.

Erysiphe heraclei is on numerous host species of various host genera of the *Apiaceae* (Braun 1995). *Zosima* has been also reported from Turkey as a new host genus by Bahcecioglu et al. (2006). *Pseudorlaya* is a new host genus for *Erysiphe heraclei.*

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Typification of *Physcia aipolioides* (*Physciaceae*, lichenized fungi)

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Abstract – The nomenclature of *Physcia aipolioides* is discussed and a lectotype is designated. Taxonomical notes on this species and similar taxa are appended.

Key words – *Ascomycota*, lichens, *Teloschistales*, types

Introduction

The genus *Physcia* s.l. has been taxonomically studied by several authors, including Czech lichenologist Josef Nádvorník (1906–77). Nádvorník (1947) described several new taxa in his monograph on the family *Physciaceae* based on research in the former Czechoslovakia. During our work dealing with mapping the distribution area of *Physcia aipolioides* (Lisická et al. 2008), we also studied Nádvorník's original material. We discovered that a holotype had not been determined and that a lectotype should be designated.

Nomenclatural notes

Nádvorník (1947) described the species as *Physcia biziana* var. *aipolioides*, providing a protologue in French (Nádvorník 1947: 82–83) and also attaching a Latin diagnosis together with diagnoses of the other newly described taxa at the end of the article (Nádvorník 1947: 123–124). Therefore, these taxa are validly published. In total, 7 specimens are mentioned in the protologue (6 from the present territory of the Czech Republic, 1 from Slovakia). A holotype was not designated, and all these specimens are syntypes. Czech lichenologist Jindřich

Suza (1890–1951) collected six specimens, all of which are in the herbarium PRM. One specimen collected by Nádvorník (Uherské Hradiště, Hluk, *Salix*) has not been found in either PRM or BRA, where Nádvorník's complete herbarium is now deposited. There are further specimens from this locality, edited in the exsiccate '*Physciaceae* exsiccatae' (Dec. 3, ed. 1951, No 24) by J. Nádvorník; however, as they were collected later (July 10, 1949), they are considered to be merely topotypes (for instance, one specimen from Černohorský's herbarium is now in PRC). [Note: No 25 of this exsiccate is from the same locality but from a different phorophyte, *Populus nigra*.]

Typification

Physcia aipolioides (Nádv.) Breuss & Türk, Wiss. Mitt. Niederösterr. Landesmus. 11: 114, 1998 FIG. 1

BASIONYM: *Physcia biziana* var. *aipolioides* Nádv., Stud. Bot. Čechoslov. 8: 123, 1947

Lectotype – [Czech Republic] Moravia, ad corticem *Aceriarum* [corrected in pencil by Suza as *Robinia,* probably correctly] prope Miroslav, IV. 1923 leg. J. Suza (PRM 640100); **designated here.**

SYNTYPES (NEOPARATYPES) – Moravia, ad corticem *Tiliae* in colle Děvičky montium Pavlovské kopce, ca 400 m, V. 1922 leg. J. Suza (PRM 640104); Moravia, Hodonín, ad *Tilias* juxta viam publicam versus Lužice, ca 160 m, V. 1923 leg. J. Suza (PRM 640099); Moravia, ad *Robinias* secus viam publicam inter Popovice [recte Popice!] et Pouzdřany, ca 200 m, VIII. 1922 leg. J. Suza (PRM 640102); Moravia, ad *Tilias* ad viam prope Liliendorf [Lesná] – Čížov apud Znojmo, 400 m, 1.5.1920 leg. J. Suza (PRM 640103); Moravia, Uherské Hradiště, Hluk, *Salix*, leg. J. Nádvorník (not found); Slovakia, Inovec, Sereď – Sv. Chrásť [Vinohrady nad Váhom], ad viam publ. ca 150 m, *Robinia pseudacacia*, VIII.1930 leg. J. Suza (PRM 640105).

COMMENTS: All specimens cited above were identified/revised by J. Nádvorník in 1945 and were later revised by Jelínková in 1971 and 1972. The lectotype was designated on basis of a rich collection that contained a well developed specimen with only few thalli of *Phaeophyscia orbicularis* and one small thallus of *Xanthoria parietina* intermixed.

Among the syntypes, PRM 640103 was initially labeled as *Physcia leucoleiptes*, with "*Ph. Biziana* v. *aipolioides*" later added to indicate a mixed collection. In 1945 J. Nádvorník annotated PRM 640105 as "*P. biziana* f. *granuligera*" – however he did not cite this name in his monograph (Nádvorník 1947).

Taxonomical notes

Physcia aipolioides is a species of the *P. stellaris* group – section *Stellaris* (Lynge) J. W. Thomson (see Thomson 1963). *P. biziana* also belongs to this group, but its thallus is smaller and splits into small secondary lobules. The *P. aipolioides* thallus is larger, thick and soft, with broad lobes that are pruinose at the margins; the centre of the thallus is verrucose but without lobules, apothecia are larger,

FIG. 1. The lectotype of *Physcia aipolioides*.

and thallus colour is grey (with a slightly yellowish tinge in herbaria) with irregular yellow patches on the underside. Huneck & Lisická (1990) identified atranorin and zeorin as secondary metabolites. Both species differ slightly not only morphologically, but also ecologically (*P. aipolioides* is an epiphytic lichen, while *P. biziana* also grows on rocks) and chorologically (*P. aipolioides* is primarily distributed in Central Europe, while *P. biziana* is a Mediterranean species). However, the distribution areas of both species are not sufficiently known yet.

Several infraspecific taxa have been described in *P. biziana* (syn. *P. ragusana* Zahlbr.):

Physcia biziana* var. *argentata (Zahlbr.) Lynge, Rabh. Krypt.-Fl. IX, Abt. 6: 85, 1935
≡ *Physcia ragusana* var. *argentata* Zahlbr., Oesterr. Bot. Z. 53: 335, 1903

Physcia biziana* var. *cinerata (Zahlbr.) Lynge, Rabh. Krypt.-Fl. IX, Abt. 6: 85, 1935
≡ *Physcia ragusana* var. *cinerata* Zahlbr., Oesterr. Bot. Z. 53: 335, 1903

Physcia biziana* var. *granuligera (Zahlbr.) Gallé, Bot. Közlem. 48: 50, 1959
≡ *Physcia ragusana* var. *granuligera* Zahlbr., Oesterr. Bot. Z. 55: 66, 1905

Physcia biziana* var. *phyllidiata Poelt & Vězda, in Vězda, Lichenes rariores exsiccati Fasc. 9 (nos 81–90): 3, 1993

Physcia biziana* var. *saxicola (Zahlbr.) Lynge, Rabh. Krypt.-Fl. IX, Abt. 6: 85, 1935
≡ *Physcia ragusana* f. *saxicola* Zahlbr., Oesterr. Bot. Z. 53: 335, 1903

Some additional varieties represent other taxa [*P. biziana* var. *leptophylla* Vězda = *Physcia rondoniana* Clauzade & Vězda; *P. biziana* var. *pulvinata* (Zahlbr.) Gallé = *Physconia grisea* (Lam.) Poelt], and *P. biziana* var. *corrugata* Dzhur. was invalidly published. Variability and distribution of infraspecific taxa within

P. biziana (incl. var. *aipolioides*) has been studied by Jelínková (1973) in eastern Central Europe.

Chorological notes

The aforementioned infraspecific taxa are poorly known and their distributions are often limited to localities mentioned only in protologues. Taxa described by Zahlbruckner are known only from Croatia, *P. biziana* var. *granuligera* from Hungary and *P. biziana* var. *phyllidiata* from Austria, Sardinia and recently also from Albania (see Hafellner & Kashta 2003: 140).

Distribution of *Physcia aipolioides* has been studied by Lisická et al. (2008). Originally, the area of known distribution covered SE Czech Republic, SW Slovakia, NE Austria and Hungary. Later, some outlying localities were discovered in the Czech Republic (central Bohemia and N Moravia), E Slovakia, and Upper Austria (Oberösterreich). Recently, *P. aipolioides* has also been found in Bulgaria and Monte Negro (see Lisická et al. 2008). Additional distributional data is needed before the relative rarity of this lichen can be determined.

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A new species of *Phragmogibbera* (*Dothideomycetes*)

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Abstract — *Phragmogibbera herbicola* on herbaceous stems from Yunnan, China is described as a new species and illustrated. Distinctions between the type species of the genus and the new species are discussed.

Key words — morphology, taxonomy

Introduction

The genus *Phragmogibbera* Samuels & Rogerson based on *P. xylariicola* Samuels & Rogerson has been monotypic since its establishment (Samuels & Rogerson 1990, Kirk et al. 2001, www.indexfungorum.org). It is characterized by uniloculate pseudothecia, nonpapillate, carbonaceous, roughened to nearly smooth ascomata, bitunicate asci, septate ascospores that are smooth with the middle two cells dark brown, and apically attached, branched, cellular pseudoparaphyses. During our studies on dothideomycetous fungi from China, a similar fungus to *P. xylariicola* was encountered. It is distinguishable and described here as a new species of *Phragmogibbera*.

Material and methods

Recent collections of *Dothideomycetes* from Yunnan Province were studied. Ascomata from substrate were rehydrated and sectioned at a thickness of 10–20 μm with a freezing microtome (YD-1508A, Yidi Medical Instrument Co., Jinhua, China). Measurements were taken from the sections and squash mounts in lactophenol cotton blue solution. Photographs were taken with a digital camera (Canon G5, Tokyo, Japan) connected with a microscope (Zeiss

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Axioskop 2 plus). The collection studied is deposited in the Mycological Herbarium, Chinese Academy of Sciences (HMAS).

Taxonomy

Phragmogibbera herbicola W.Y. Zhuang & W.Y. Li, sp. nov. FIGS 1–4

MYCOBANK MB 512646

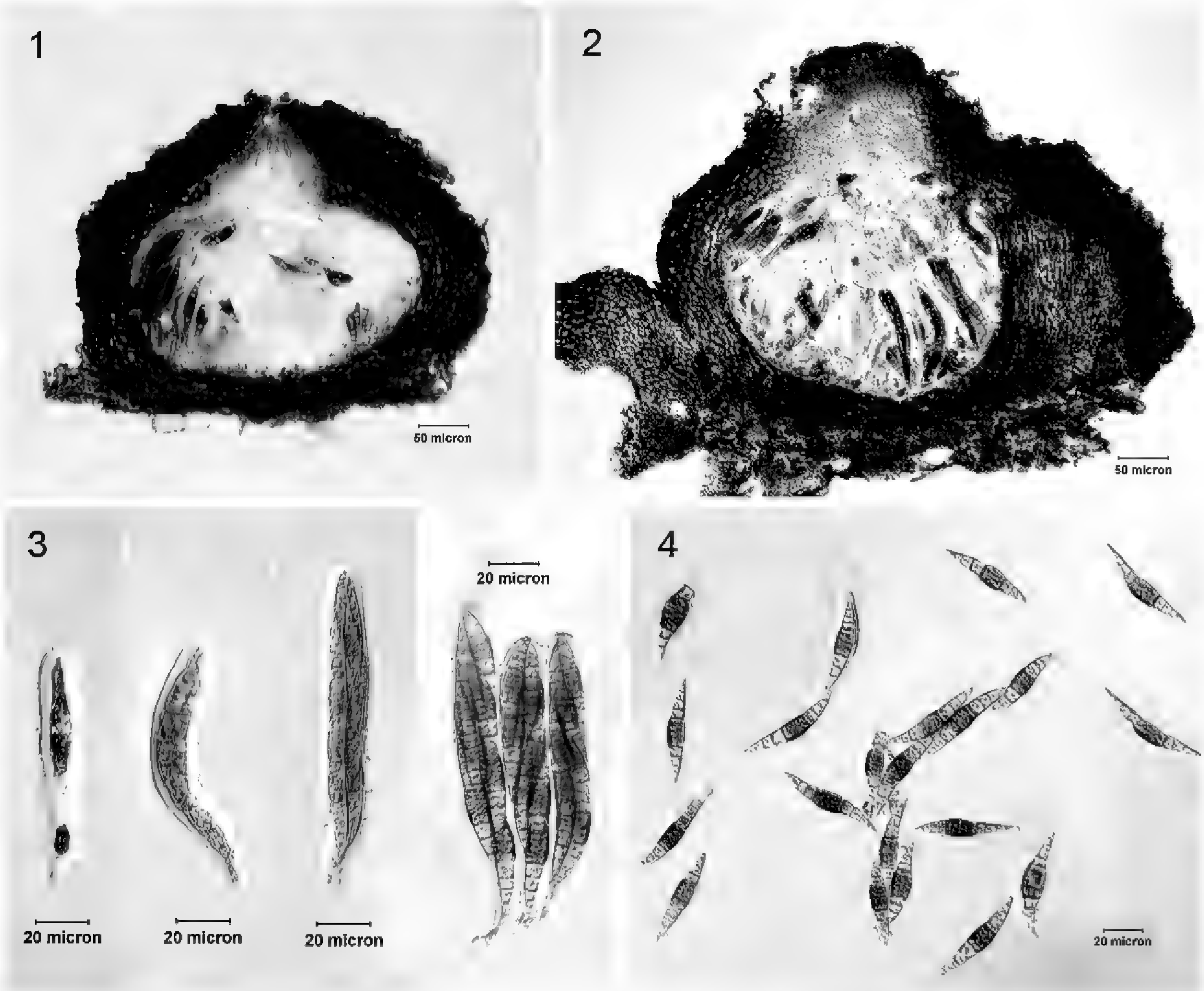
ETYMOLOGY: refers to the substrate of the fungus.

Pseudotheciis subglobosis, 270–440 µm diam., 280–335 µm alt.; ascis clavatis, 8-sporis, 127–157 × 15–22 µm; ascosporis fusiformibus, 9-septatis, cellulis duabus mediis obscure brunneis , 56–70 × 9.6–12.2 µm.

HOLOTYPE: China. Yunnan, Dali, on dead stem of an unidentified herbaceous plant, 1800 m, 12-XI-2006, W.Y. Li 7334, HMAS 178154. Epitype: CGMCC 3.10146 (ex type culture).

Ascomata initially immersed, becoming erumpent through epidermis, mostly solitary, occasionally gregarious; pseudothecia carbonaceous, uniloculate, subglobose, nonpapillate or with a slightly protruding apex, dark brown to nearly black, surface slightly roughened, 270–440 µm diam, 280–335 µm high, opening through a well-developed ostiole; peridium of textura angularis, 44–105 µm thick, composed of dark brown, thick-walled cells 2.8–8.3 µm diam., cells at ascomatal surface not becoming blue-green in KOH; pseudoparaphyses branched, cellular, hyaline, septate, 2–3 µm wide; asci bitunicate, clavate to cylindrical-clavate, 8-spored, 127–157 × 15–22 µm; ascospores fusiform, tapering above and below to very narrow or nearly pointed ends, mostly 9-septate, with two middle cells brown to dark brown and swollen, other cells much paler to subhyaline, not constricted at septum, irregularly biseriate, 56–70 × 9.6–12.2 µm, two dark cells 12–18.3(–22) × 8.5–12.5 µm, other cells narrower. Anamorph unknown.

NOTES: Consulting the early treatments of bitunicate ascomycetes by von Arx & Müller (1973) and Barr (1987) and considering the transversely septate ascospores as well as the monocotyledon substrate, *Leptosphaeria* Ces. & De Not. is a possible genus for our fungus. However, it is obvious that the gross morphology and anatomic structure of the Chinese collection do not fit any species of *Leptosphaeria*. In a study on fungi from the Guayana Highlands by Samuels & Rogerson (1990), the genus *Phragmogibbera* was published. The Chinese species agrees with the type species of the genus, *P. xylariicola*, from Venezuela in the shape, texture, and anatomic structure of pseudothecia, ascus apical apparatus, and shape of ascospores, especially the presence of the two brown middle cells in spores. *Phragmogibbera herbicola* with larger, 9-septate ascospores differs from *P. xylariicola* having 3-septate ascospores that are 30–37.5 × 5–7.5(–10) µm. In addition, cells at the ascomatal surface of *P. herbicola* do not change color in KOH while those of *P. xylariicola* turn blue-



FIGS 1–4. *Phragmogibbera herbicola* (from holotype): 1–2. Structure of pseudothecium in longitudinal section; 3. Asci at different developmental stages; 4. Ascospores released from asci.

green. Finally, *P. herbicola* occurs herbaceous stems while *P. xylariicola* was found on fruitbodies of *Xylaria*.

Acknowledgments

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A new *Marasmius* on *Castanea sativa* from Turkey

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Abstract — *Marasmius castaneophilus*, a new agaric (*Marasmiaceae, Agaricales, Basidiomycota*) growing on sweet chestnut husks in Turkey, is described and illustrated. Its taxonomic position within the genus is discussed.

Key Words — new taxa, biodiversity, Turkish macromycota

Introduction

Marasmius is a very large genus with as many as 1695 taxa (Anon 2008), even after being critically circumscribed by the transfer of some taxa to *Collybia, Gymnopus, Marasmiellus* and *Setulipes*. It is predominantly tropical in distribution (Singer 1986), with forty-two species now known from Europe (Antonin & Noordeloos 1993).

The species within this restricted concept are often highly specific as to their host requirements. This specificity is not only to the host, but to a particular part of the host colonized, whether it be leaf lamina, midrib or petiole (Watling 1982). Traditionally the genus was split into those with pileipellis in the form of Rameales-structure, viz. cutis of diverticulate hyphae, and setiform stipe (sect. *Androsacei* Kühner, = *Setulipes* Antonín) and those with a hymeniform pileipellis (other *Marasmius* sections). As traditionally accepted, the genus

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This article is dedicated to Dr. Fadime Yılmaz (1971-2005), Muğla University, who made many contributions to our knowledge of Turkish macrofungi (including members of the genus *Marasmius*) but, sadly, died in a car accident in 2005.

Marasmius contains a group of white or pale coloured, small fruitbodies usually characterized as having an insititious stipe and well-developed cystidia and referred to sect. *Epiphylli* Kühner. European representatives of this section include *M. epiphylloides, M. epiphyllus, M. hellebori-corsici, M. saccharinus, M. setosus,* and *M. tremulae (= M. favrei)*. However, molecular studies place this section not in *Marasmius* s. str., but rather close to the *Physalacriaceae* (Owings & Desjardin 1997, Moncalvo et al. 2002, Wilson & Desjardin 2005), restricting the genus *Marasmius* only to representatives of the sections *Marasmius, Sicci, Globulares, Hygrometrici, Neosessiles* and *Leveilleani*. Recent studies in Turkey have encountered an additional member of the group related to *M. epiphylloides* that is apparently confined to colonizing the husks of *Castanea sativa*. The species described formally below raises the total number of members of *Marasmius* in Turkey to 23 (Solak et al. 2007).

Taxonomic description

Marasmius castaneophilus Işıloğlu, Allı, Solak & Watling, **sp. nov.** FIGS. 1–5

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Pileus 4–4.5 mm convexus vel plano-convexus prostremo plano, interdum depressus, albus, radiato-striatus vel radiato-sulcatus ad marginem interdum undulato-lobatus. Lamellae lato-adnatae, distantes, furcatae, plicatae, albae. Stipes 20–30 × 0.5–1 mm., filiformes vulgo flexuosus, glabrus, ad apicem hyalinum prostremo ad basim rufo-brunneum, vulgo senecutate infra atro-ferrugineus. Caro albo. Odor, sapor nullus. Sporae 10–12 × 4–5 µm, ellipsoideo-oblongae vel fusiformae, laevae, hyalinae, inamyloideae. Basidia 45–50 × 4–6 µm, 4-sporigera. Cystidia faciei lamellarum fusiformia vel clavata, tenuio-tunicata; cystidia aciei lamellarum 1) 30–40 × 5–8 µm, subfusiformia vel lageniformia et 2) 15–35 × 15–20 µm, clavata vel pyriformia ornamentiae. Cellulae cuticulae pilei hymeniformae 1) 15–18 × 8–10 µm, clavata, tenuio-tunicata – 'rotalis-typus' et 2) 20–27 × 4–5 µm, fusiformiae vel lageniformiae, tenuio-tunicata, laevae. Hyphae fibulatae. Trama inamyloideae. Ad Castanea sativa cupulus. Turkey; İzmir, Ödemiş Typus Ha 2842 in E.

PILEUS 4–4.5 mm, convex to plano-convex then irregularly applanate, sometimes depressed, white, radially striate or grooved with undulating margin (FIG. 1). GILLS broadly adnate, poorly developed, distant, vein-like, forked, plicate and without lamellulae, always white. STIPE 20–30 × 0.5–1 mm., hair-like, central, rarely eccentric, glabrous, smooth, twisted when dry, stiff and tough, hyaline when young, reddish brown below when old, blackish brown when dry. FLESH very thin and white. SMEL AND TASTE indistinct. SPORE PRINT White. SPORES 10–12 × 4–5 µm, fusiform to narrowly ellipptic with a long apiculus (FIG. 2), smooth, thin-walled, colourless in alkali, inamyloid. BASIDIA 45–50 × 4–6 µm, clavate, hyaline, thin-walled, 4-spored, with clamps. BASIDIOLES 35–40 × 4–5 µm, clavate, with clamps. PLEUROCYSTIDIA 40–70 × 9–12 µm, fusiform to clavate, thin-walled and hyaline (FIG. 3). CHEILOCYSTIDIA of two types; 1. type: 30–40 × 5–8 µm subfusiform to lageniform with long neck, thin-walled (FIG.

Fig. 1. *Marasmius castaneophilus* (from holotype; photo by H.Allı)

4). 2. type: 15–35 × 15–20 µm, broom cells of the rotalis-type, broadly clavate to pyriform with projections. Pileipellis hymeniform, a mixture of three types of elements. 1) 15–18 × 8–10 µm, clavate, thin-walled, rotalis-type cells with long projections 2) smooth clavate cells and 3) 20–27 × 4–5 µm, fusiform or lageniform, thin-walled and smooth (Fig. 5); the former the most common. Clamp-connections present.

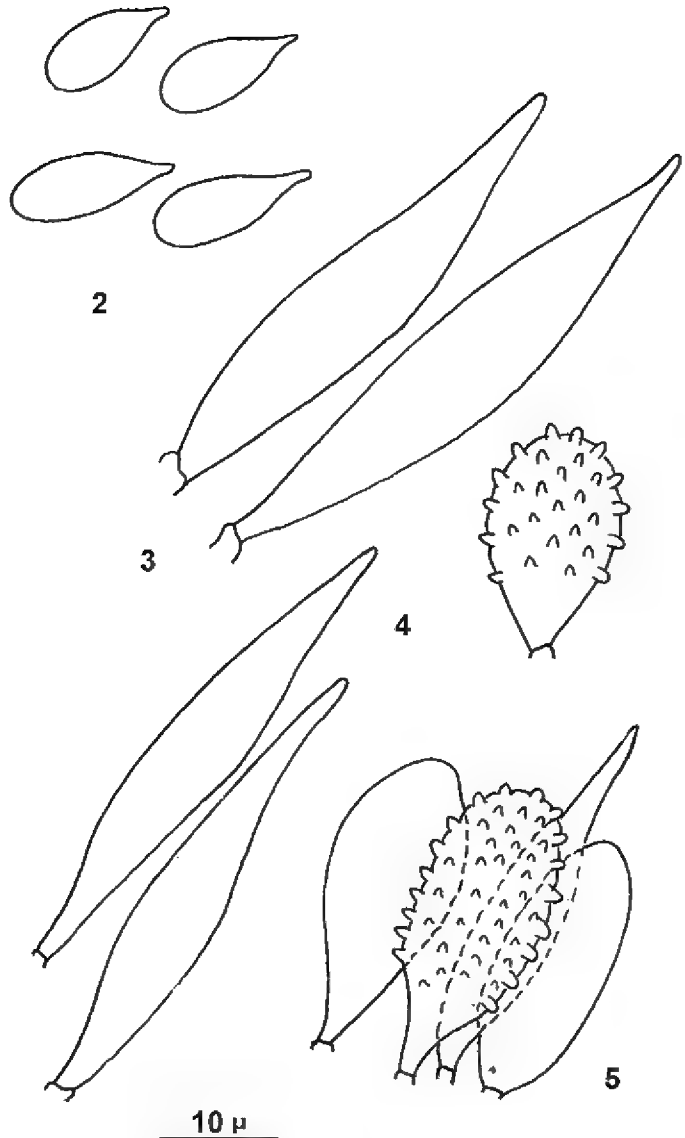
Chemical reactions. No part of basidiome dextrinoid or amyloid.

Habitat. In clusters on dead husks of *Castanea sativa.*

Specimen examined. Turkey; İzmir, Ödemiş, Elmabağı village, in natural forest of mixed *Pinus nigra* and *Castanea sativa*, 11 November 2007, Ha 2842. **Holotype:** in E.

Discussion

Marasmius castaneophilus is easily recognized in the field by its unique habitat on sweet chestnut husk, pure white pileus surmounting a stipe that becomes red brown upwards with age, lanceolate pileocystidia, and large basidiospores. Following Antonín & Noordeloos (1993), this species belongs to sect. *Epiphylli* subsect. *Epiphylloidei* Singer, whose taxa are characterized by having pilepellis composed of a mixture of smooth cells and rotalis-type broom cells, absence of distinct collarium, marasmoid or collybioid basidiomes, filiform and insititious



Figs. 2–5. *Marasmius castaneophilus* (from holotype).
2. spores, 3. pleurocystidia, 4. cheilocystidia, 5. pileipellis

stem, white or pale pileus, vein-like and reduced gills, and non-dextrinoid hyphae. It is closely related to *M. epiphylloides* (Rea) Sacc. & Trotter and can be distinguished confidently both morphologically and microscopically. *Marasmius castaneophilus* has a longer hair like stem, larger basidiospores, and two types of cheilocystidia. It also differs by its association with sweet chestnut husks.

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Sporisorium spinulosum sp. nov. (*Ustilaginaceae*) on *Capillipedium* (*Poaceae*) from China

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Abstract—A new species, *Sporisorium spinulosum* on *Capillipedium parviflorum* is described. It was collected from Gaoligong Mountains of Yunnan Province in China.

Key words—*Ustilaginomycotina*, smut fungi, taxonomy

During the mycological expedition to Gaoligong Mountains of Yunnan Province in 2008, the authors and their colleagues collected many smut fungi. Among them, a new *Sporisorium* species on *Capillipedium parviflorum* was discovered. Its sori destroy the whole inflorescence and possess a long, single columella. According to Vánky (2004), 15 *Sporisorium* species have been reported on *Bothriochloa*, *Capillipedium*, and *Dichanthium*. The new species is similar to *Sporisorium tenue* (Syd. & P. Syd.) Vánky (Vánky 2004) and *Sporisorium taianum* (Syd.) L. Guo (Guo 1990) in having relatively small ustilospores. It differs from *S. tenue* in having a single unbranched columella, smooth surface between ustilospore spines as seen in SEM, uneven ustilospore walls, sterile cells in chains, and no spore balls. In comparison, *S. tenue* has a simple or ramified columella, forms ephemeral spore balls, has dense warts between ustilospore spines in SEM, even ustilospore walls, and irregular groups of sterile cells (Vánky 2004). The new species differs from *S. taianum* in having sori throughout the entire inflorescence and ustilospores with minute and sparse spines and from *S. taianum*, which has ustilospores with minute and dense warts and sori in the spikelets. The new species is described as:

*corresponding author

Sporisorium spinulosum S.H. He & L. Guo, **sp. nov.** FIGS. 1–4

MycoBank MB 512662

Sori in inflorescentiis evoluti, longe cylindrici, 35–110 × 1–1.5 mm, a vagina folii supremi partim tecti, primo peridio cinerascentibrunneo cooperti, quo longitudinaliter rupto. Columella singula. Massa sporarum atrobrunnea, semiagglutinata vel pulverulenta. Ustilosporae subglobosae, ovoideae, ellipsoideae vel leniter irregulares, 6.5–9 × 5–7.5 µm, flavidobrunneae, saepe pallidiores in unilatis; pariete inaequaliter crasso, 0.5–1 µm, subtiliter sparse echinulato. Cellulae steriles subglobosae, ellipsoideae vel irregulares, 7.5–16.5 × 4–12.5 µm, hyalinae vel flavidae, in catenis; pariete 1–2 µm crasso, leves.

Sori in the whole inflorescence, long cylindrical, 35–110×1–1.5 mm, partly hidden by the uppermost leaf sheath, at first covered by a greyish-brown peridium which later ruptures longitudinally. Columella single, not ramified and often bent at the top. Spore mass blackish-brown, semi-agglutinated to powdery. Ustilospores subglobose, ovoid, ellipsoidal or slightly irregular, 6.5–9 × 5–7.5 µm, yellowish-brown, often paler on one side; wall unevenly thickened, 0.5–1 µm, finely and sparsely echinulate as seen by SEM. Sterile cells subglobose, ellipsoidal or irregular, with one or two flattened sides, 7.5–16.5 × 4–12.5 µm, hyaline or pale yellow, in chains; wall 1–2 µm thick, smooth.

SPECIMENS EXAMINED—On *Capillipedium parviflorum* (R. Br.) Stapf (*Poaceae*), China: Yunnan, Fugong, Wangjidu, alt. 1400 m, 28. VIII. 2008, S.H. He, Y.F. Zhu & L. Guo 2229, HMAS 193085 (holotype), HUV 21557 (isotype).

To date, six species of *Sporisorium* have been recorded on *Bothriochloa*, *Capillipedium* and *Dichanthium* in China. They are: 1) *Sporisorium andropogonis* (Opiz) Vánky (Ling 1953, Guo 1990), 2) *S. andropogonis-annulati* (Bref.) S.R. Wang & M. Piepenbr. (Wang & Piepenbring 2002), 3) *S. doidgeae* (Zundel) Langdon & Fullerton (Ling 1945, Ling & Chen 1945, Guo 1990, Vánky 2004), 4) *S. reticulatum* (B. Liu, Z.Y. Li & Du) Vánky (Liu et al. 1979, Vánky 2004), 5) *S. taianum* (Sydow 1929, Guo 1990) and 6) *S. spinulosum* (in this paper).

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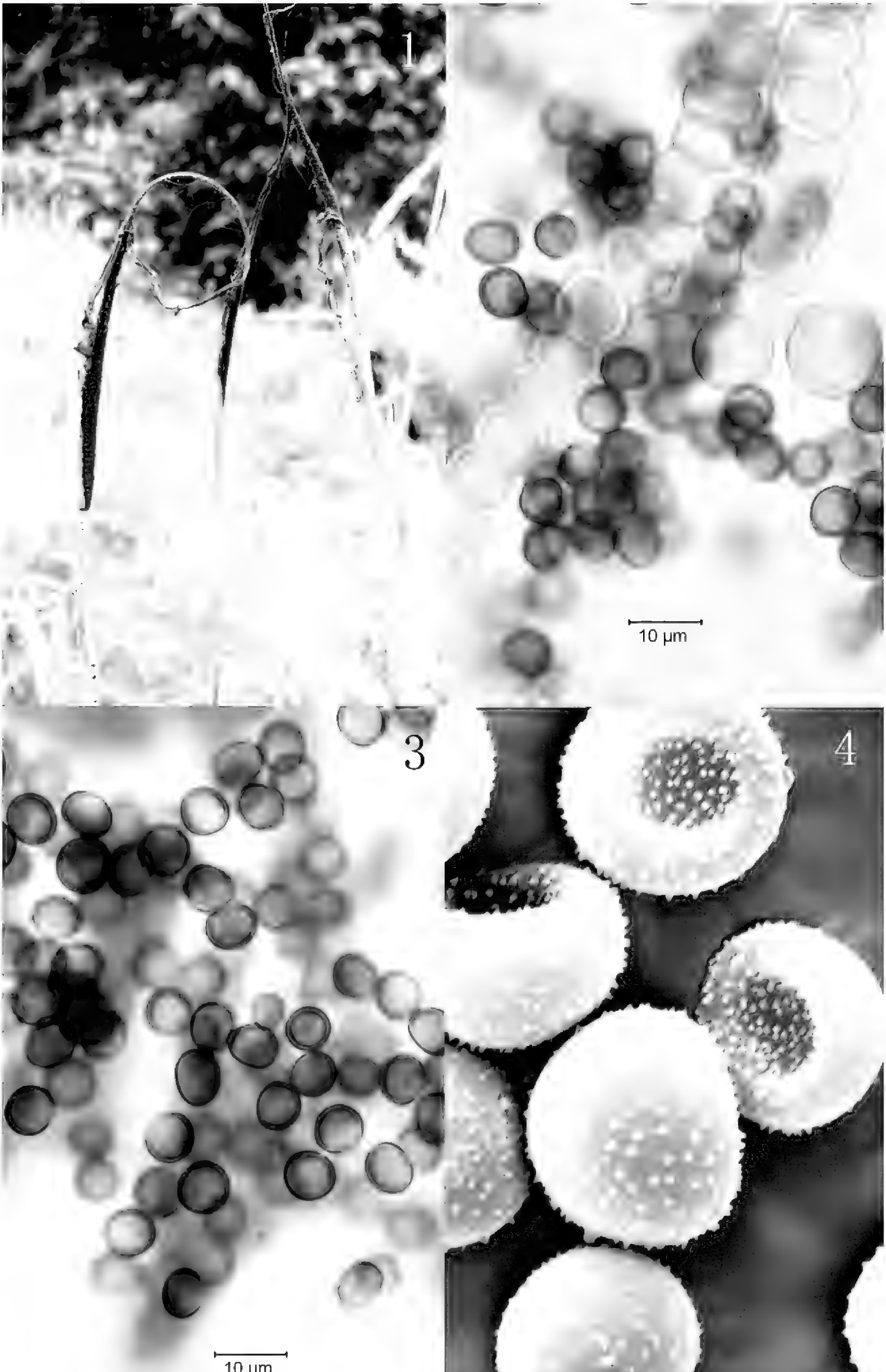
FIGS. 1–4. *Sporisorium spinulosum* on *Capillipedium parviflorum* (HMAS 193085, holotype). 1. Sori. 2. Ustilospores and sterile cells as seen by LM. 3. Ustilospores as seen by LM. 4. Ustilospores as seen by SEM.


1
10 μm
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A checklist of African myxomycetes

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Abstract — A comprehensive checklist of the species of myxomycetes known from Africa does not exist, and the reported records are found in various sources scattered throughout the literature. In the study described herein, an effort was made to compile all known records of African myxomycetes from published articles, reports and databases. Our initial findings indicate that there are 294 species representing 49 genera reported from or known to occur in Africa. Of the 58 countries and territories on the entire continent, no records of myxomycetes apparently exist for 27 countries. A complete annotated species list is provided at http://www.mycotaxon.com/africamyxomycetes2.

Key words — mycetozoans, slime molds, distribution, taxonomy

Introduction

Information on African myxomycetes is scattered in various articles, reports and databases, which in most cases have a limited distribution. The first published checklist of African myxomycetes (Duthie 1917) included 108 species belonging to 26 genera. Over the past 90 years, several surveys for myxomycetes have been carried out in several African countries and territories. For example, such surveys have yielded regional species lists in North Africa (Faurel et al. 1966) and Mediterranean countries (Lado 1994). In other regions, surveys and collections of myxomycetes have contributed to the development of species lists in some countries including Tanzania (Ukkola 1998), Kenya (Ndiritu GG unpubl. data), Malawi and Zambia (Rammeloo & Mitchell 1994), Seychelles and Madagascar (Ing & Hnatiuk 1981), Mozambique (Almeida 1974b), Angola (Almeida 1974a), South Africa (Doidge 1950, Winsett KE unpubl. data), Gambia (Härkönen 1981), Liberia (Farr 1959), Nigeria (Ing & McHugh 1968) and Sierra Leone (Yamamoto et al. 1996). The idea of compiling this checklist was driven by the need to have an online updatable checklist of African myxomycetes and, by extension, allowing one to determine species occurrence in Africa.

Study methods

Records of myxomycetes were sought for 58 countries and territories in Africa. Countries were classified into five major regions primarily following present geo-political boundaries, although some modifications were made to reflect the African climatic regionalization (Goudie 1999). The five geo-political and eco-climatic regions are North, East, South, Central and West Africa. Additionally, the myxomycete species list of the Canary Islands was analyzed herein for comparison purposes. The taxonomic names used follow the nomenclature criteria proposed by Hernández-Crespo & Lado (2005) and only accepted taxonomic names were used. The total number of species reported from each country was calculated. Lastly, numbers of genera and species were compiled for each of the five regions.

Results

An examination of all known and currently available records indicates that myxomycetes have been reported from only 31 of 58 countries and territories in Africa. Overall, 294 species representing 49 genera were compiled from 31 countries. Only three countries had more than 100 species. These were Tanzania with 133 species (or 45% of all species known from Africa), Morocco with 123 species (42%) and South Africa with 107 species (36%). Interestingly, the relatively small Canary Islands, where more intensive surveys have been carried out, had 121 species. Other countries where moderate numbers of species have been reported include Algeria (79, 27% of all species), Nigeria (77, 26%), Angola (72, 24%), Kenya (70, 24%), Seychelles (56, 19%), Liberia (52, 18%) and Malawi (47, 16%).

Data for the occurrence of a species in a country or territory show that most species have rarely been encountered in the records of study in Africa, with 117 (40% of all species) and 48 (16%) species found in only one country or two countries, respectively. Twenty eight species were regarded as frequent (recorded in 10 to 19 countries), 57 species as common (occurring in five to nine countries) and another 43 species can be considered as occasional (found in three to four countries). An assessment of the numbers of genera and species found in Africa indicates that *Physarum*, with a total of 59 species, was the most dominant genus, followed by *Didymium* (24), *Diderma* (21), *Arcyria* (19), *Licea* (15), *Cribraria* (13), *Badhamia* (12) and *Trichia* with 11 species. Although the numbers of records in the five regions varied, the taxonomic composition with respect to genera and species was similar. Numbers of records obtained from countries in Central Africa were too low to allow meaningful comparison with other regions.

Discussion

A total of 294 species representing 49 genera, found in roughly 68 sources, are reported from Africa. This corresponds to only about 33% of the myxomycetes

(ca. 880 species) known world wide. The low number of species reported from Africa and its territories can be attributed largely to few surveys and inadequately skilled local taxonomists. The infancy of myxomycete knowledge in Africa is consistent with the fact that no myxomycete records exist for 27 countries. Substantial myxomycete records are found in only Tanzania (Ukkola 1998) and Morocco (Malençon & Bertault 1969), where extensive surveys have been undertaken. As might be predicted, myxomycete records in these two countries are comparable to the 121 species known for the much smaller Canary Islands, where several intensive surveys have been done (Beltrán et al. 2004). Moreover, the 17 species reported in the Canary Islands have not yet been reported from the Africa continent. In general, myxomycete species richness in the African continent is expected to be moderate to high, particularly if one considers its overall size and the presence of large biomes ranging from tropical forests to deserts, grasslands and Mediterranean woodlands.

The observed distribution and occurrence of myxomycetes at the level of genera and order were to a large degree comparable with the data obtained from other regions and countries worldwide (http://www.discoverlife.org/). All of the 23 most abundant species in Africa are also globally widespread and cosmopolitan. However, at the present time no serious conclusions can be made relating to the occurrence and distribution of African myxomycetes using available data, which is inadequate.

Emerging methods to study myxomycetes recommend the use of both field collections and moisture chamber cultures as well as sampling all substrates and microhabitats with which myxomycetes are associated (Spiegel et al. 2004). The few studies that have attempted to use both methods in Africa and which have obtained promising results include those of Ukkola (1998) in Tanzania. Similarly, acceptable results were obtained with the moisture chamber culture technique (Härkönen 1981, Abdel-Raheem 2002). For the most part, results obtained using only field collections have been unsatisfactory (Farquharson & Lister 1916, Farr 1959, Kost 2002). Records used to compile this list were based primarily on field collections on ground litter. It is imperative that future studies in Africa take into consideration the richness of other substrates, for example the value of aerial litter in tropical habitats (Schnittler et al. 2002, Ndiritu unpubl.) and anthropogenic ecosystems (e.g. Tran et al. 2008).

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South Florida microfungi: *Veramycella bispora*, a new palmicolous anamorphic genus and species, with some new records for the continental USA

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Abstract — A new anamorphic genus *Veramycella*, with *V. bispora* as the type species, is described and illustrated from rachides of dead leaves of *Sabal palmetto* in southeastern Florida, USA. The genus is characterized by having 3-distoseptate, polymorphic conidia produced in simple, acropetal chains of two, and polyblastic, terminal or intercalary, sympodially proliferating conidiogenous cells bearing widely spaced, flattened, non-protuberant, unthickened, not darkened conidiogenous loci, disposed in conidiophores with enteroblastic, percurrent regenerative proliferations. It is compared with morphologically similar anamorphic genera and species having sympodial conidiogenesis and catenate conidia. Thirteen other hyphomycetes are recorded for the first time for the continental United States. A new combination *Rhexoacrodictys martinii*, is proposed and discussed.

Key words — *Anungitopsis*, *Junewangia*, palm fungi, *Veramyces*

Introduction

Continuing our studies of saprobic microfungi occurring in natural locations of southeastern Florida (Delgado 2008a, b), several interesting hyphomycetes (anamorphic fungi) were collected on plant debris. A peculiar anamorph with distoseptate conidia in chains of two and sympodially proliferating conidiogenous cells was found among them, growing on dead leaves of *Sabal palmetto*. When first examined, the fungus was tentatively considered as a new species of *Veramyces* Matsush. (Matsushima 1993; non *Veramyces* Subram., nom. illegit.), a genus so far been monotypic. However, after careful examination, the Florida fungus differs from *Veramyces* in certain essential respects, and it cannot be accommodated in any other previously known anamorphic genus. Therefore, it is described here in a new monotypic genus *Veramycella*. The type specimen and other specimen examined are deposited in the Herbarium of

the U.S. National Fungus Collections (BPI). Thirteen other hyphomycetes are newly recorded for the continental USA, four of them previously collected or described from overseas American territories. Short descriptions and comments about their morphology, taxonomy and geographical distribution are provided for each taxon. A new combination *Rhexoacrodictys martinii*, is proposed and discussed based on a specimen collected in the surveyed areas.

Taxonomic description

Veramycella G. Delgado, **anam. gen. nov.**

MycoBank MB512669

Ad fungus anamorphicus, hyphomycetes, pertinens. Coloniae *in substrato naturali pilosae, effusae.* Mycelium *plerumque in substrato immersum, ex hyphis septatis, ramosis, laevibus, brunneae compositum.* Stromata *saepe praesentia.* Conidiophora *macronemata, mononemata, singula vel aggregata, erecta, simplicia, recta vel leviter flexuosa, cylindrica, laevia, brunnea, apicem versus pallidiora et tenuitunicata, regenerationibus percurrentia.* Cellulae conidiogenae *polyblasticae, in conidiophoris incorporatae, terminales vel intercalares, sympodiales. Loci conidiogeni applanati, non protuberantes, non incrassati, non fuscati, apicales vel laterales.* Conidiorum secessio *schizolytica.* Conidia *holoblastica, acropleurogena, catenata, in catenis simplicibus, acropetis formata, polymorphica, mitrata, fusiformia, clavata vel pyriformia, distoseptata, subhyalina vel pallide olivacea, laevia.* Teleomorphosis *ignota.*

Species typica—*Veramycella bispora* sp. nov.

Anamorphic fungi, hyphomycetes. Colonies on natural substratum hairy, effuse. Mycelium predominantly immersed in the substrate, composed of septate, branched, smooth-walled, brown hyphae. Stromata usually present. Conidiophores macronematous, mononematous, single or in groups, erect, unbranched, straight or slightly flexuous, cylindrical, smooth-walled, brown, paler and thinner-walled toward the apex, regenerating percurrently. Conidiogenous cells polyblastic, integrated, terminal and intercalary, sympodial. Conidiogenous loci flattened, non-protuberant, unthickened, not darkened, apical and lateral. Conidial secession schizolytic. Conidia holoblastic, acropleurogenous, catenate, in simple, acropetal chains, polymorphic, mitrate, fusiform, clavate, pyriform, distoseptate, subhyaline to pale olivaceous, smooth-walled. Teleomorph unknown.

Etymology—*Veramyces*, a generic name of hyphomycetes; Latin, -*ella*, a suffix meaning diminutive.

Veramycella bispora G. Delgado, **anam. sp. nov.** Figs. 1–12

MycoBank MB512670

Ad fungus anamorphicus, hyphomycetes, pertinens. Coloniae in substrato naturali pilosae, effusae, brunneae. Mycelium plerumque in substrato immersum, ex hyphis septatis, ramosis, laevibus, brunneis, 1.5–2 µm diam. compositum. Stromata absentia ad praesentia, non erumpentia, subrotundata vel irregularis, atrobrunneae vel nigrescentia. Conidiophora

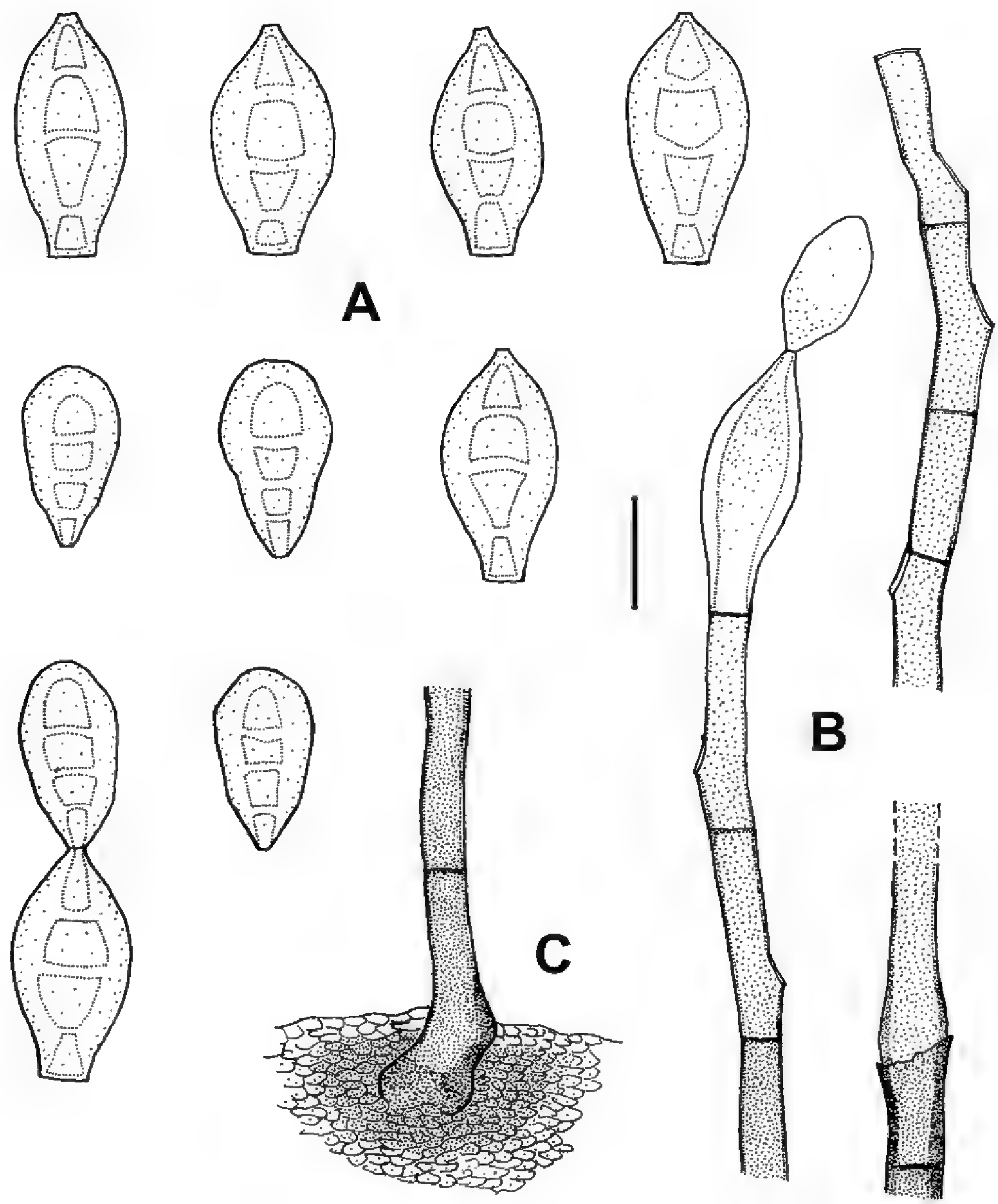


Fig. 1. *Veramycella bispora*, from holotype (BPI 878843).
A. Conidia. B. Conidiophores, conidiogenous cells and developing conidia.
C. Detail of the stroma. Scale bar: 10 µm.

macronemata, mononemata, singula vel aggregata, erecta, simplicia, recta vel leviter flexuosa, cylindrica, 3–12-septata, laevia, brunnea, apicem versus subhyalina vel pallide brunnea et tenuitunicata, usque ad 260 µm longa, 3–4 µm crassa, ad basi inflata, 5–10 µm crassa, cum 1–3 proliferationibus percurrentibus enteroblasticis. Cellulae conidiogenae polyblasticae, in conidiophoris incorporatae, primo terminales, tarde terminales vel intercalares, cylindricae, recta vel leviter geniculatae, sympodiales. Loci conidiogeni late dispositi, applanati, non protuberantes, non incrasati, non fuscati, apicales vel laterales. Conidiorum secessio schizolytica. Conidia holoblastica, acropleurogena, polymorphica, sicca, catenata, in catenis simplicibus, acropetis, brevis formata, ex 2 conidiis compositis, conidia primaria mitrata usque ad late fusiformia, ad apicem conico-truncata, ad basim truncata, conidia secundaria clavata usque ad pyriformia, ad apicem rotundata, ad basim conico-truncata, 3-distoseptata, subhyalina vel pallide olivacea, laevia, (13–)15–21(–24) × (6.5–)7–9(–9.5) µm. Teleomorphosis ignota.

Holotype—UNITED STATES. Florida: Miami-Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachides of dead leaves of *Sabal palmetto* (Walter) Lodd. ex Schult., IX.22.2007, coll. G. Delgado (BPI 878843).

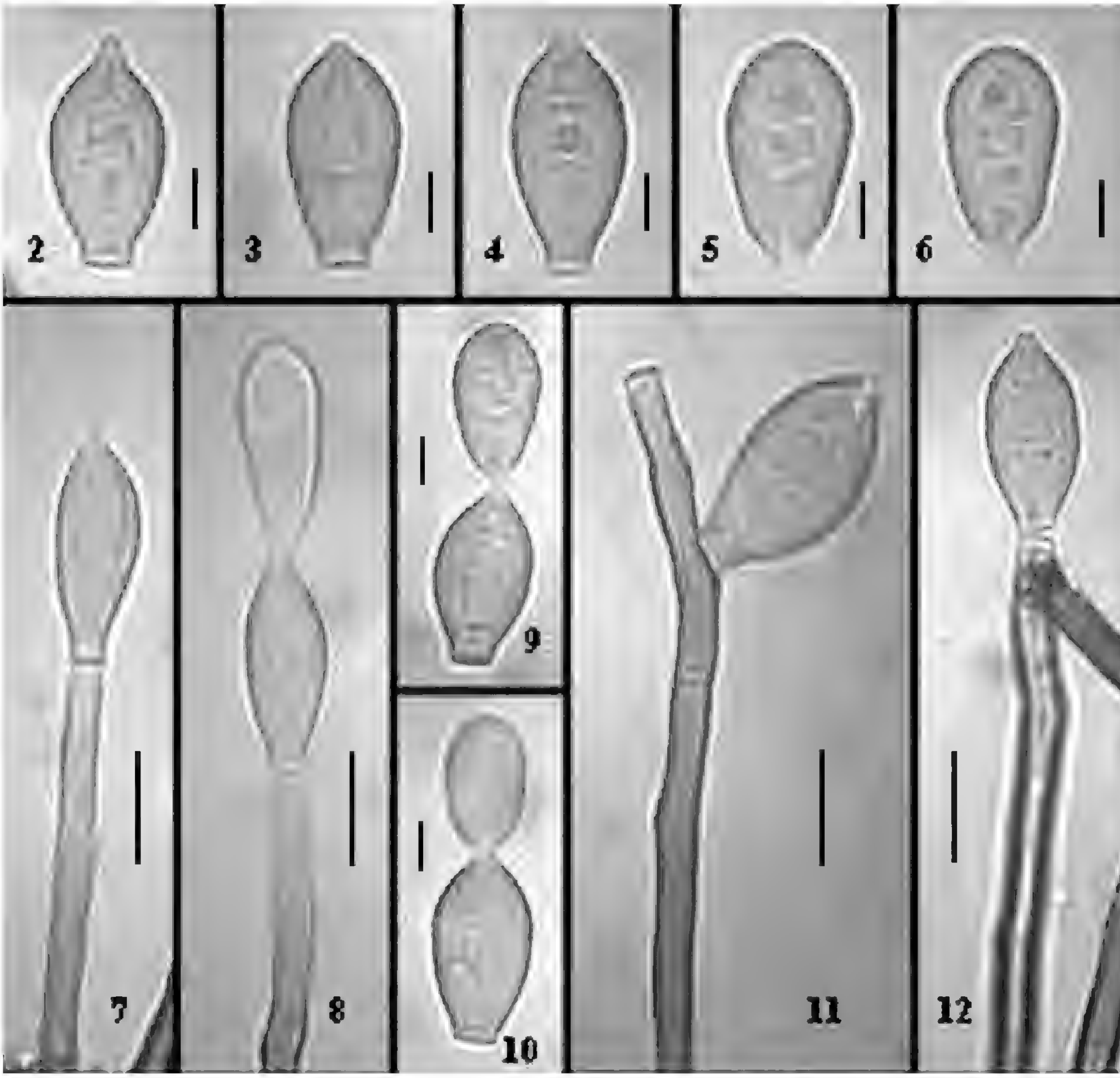
Etymology—Latin, *bispora*, referring to the two-spored conidial chains found in this species.

Colonies on natural substratum hairy, effuse, brown. Mycelium predominantly immersed in the substrate, composed of septate, branched, smooth-walled, brown hyphae, 1.5–2 µm wide. Stromata usually present, often well developed, flattened, subsphaerical to irregular, dark brown to blackish brown. Conidiophores macronematous, mononematous, single or in groups, arising from stromata or not, erect, unbranched, straight or flexuous, cylindrical, 3–12-septate, smooth-walled, brown, subhyaline to pale brown and thinner-walled toward the apex, up to 260 µm long, 3–4 µm wide, inflate at the base, 5–10 µm wide, often with one to three frequently nodose, enteroblastic percurrent regenerative proliferations. Conidiogenous cells polyblastic, integrated, terminal becoming intercalary after apical growth, cylindrical, straight or slightly geniculate, sympodial. Conidiogenous loci widely spaced, flattened, non-protuberant, unthickened, not darkened, apical and lateral. Conidial secession schizolytic. Conidia holoblastic, acropleurogenous, polymorphic, dry, catenate, in short, simple, acropetal chains of two: the first conidium mitrate to broadly fusiform, apex conico-truncate, base truncate; the second (apical) conidium developing blastically from the apex of the first conidium, clavate to pyriform, rounded at the apex, tapered to a conico-truncate base; 3-distoseptate, subhyaline to pale olivaceous, smooth-walled, (13–)15–21(–24) × (6.5–)7–9(–9.5) µm. Teleomorph unknown.

Other specimen examined—UNITED STATES. Florida: Miami-Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachides of dead leaves of *Sabal palmetto* (Walter) Lodd. ex Schult., VI.30.2007, coll. G. Delgado (BPI 878836).

Discussion

Veramycella bispora possesses a unique combination of features that readily distinguishes it from other genera and species of hyphomycetes with catenate conidia and polyblastic, sympodial conidiogenesis. These include the presence of 3-distoseptate, subhyaline to pale olivaceous, polymorphic conidia in simple, acropetal chains of two, the first conidium mitrate to broadly fusiform in shape, the second conidium produced blastically from the tip of the first conidium and clavate to pyriform. Conidiophores regenerate percurrently 1 to 3 times, with frequently nodose enteroblastic proliferations. The upper, fertile portion bears holoblastic, sympodially proliferating conidiogenous cells with widely spaced, flattened, non-protuberant, unthickened, not darkened conidiogenous loci, laterally but also apically situated when the conidiogenous cell is terminal.



Figs. 2–12. *Veramycella bispora*, from holotype (BPI 878843). 2–6. Conidia. 7–8, 11–12. Conidiophores, conidiogenous cells and conidia. 9–10. Conidia in chains. Scale bars: 2–6, 9–10 = 5 µm; 7–8, 11–12 = 10 µm.

Veramycella is closely similar to the monotypic genus *Veramyces* (Matsushima 1993). *Veramyces manuensis* Matsush., the type species, is known from a single specimen collected on a rotten petiole of an unidentified palm in Peru. Both genera share in common the presence of distoseptate, phragmosporous, polymorphic, pale-colored conidia forming unbranched, acropetal chains and polyblastic conidiogenous cells that proliferate sympodially. However, conidiophores in *Veramyces* are mainly simple but sometimes sparingly branched, non straight, without percurrent proliferations, and the conidiogenous cells bear multiple protuberant, conico-truncate denticles, closely arranged or distantly spaced in an irregular fashion. The conidia of *V. manuensis* are 0–5-distoseptate and disposed in chains of three to five, the first conidia cylindrical in shape, the secondary conidia fusiform. The combination of conidiophores with enteroblastic, percurrent regenerative proliferations and sympodial

conidiogenous cells associated with flattened, not denticulate conidiogenous loci clearly separate *Veramycella* from *Veramyces*.

Some members of the genus *Anungitopsis* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1990, Castañeda et al. 1996) morphologically resemble *Veramycella bispora*. They share a similar conidiogenesis and comparable catenate conidia developed in short, acropetal, unbranched chains. Crous et al. (2007) recently transferred *A. amoena* R.F. Castañeda & Dugan, and *A. intermedia* Crous & W.B. Kendr. to *Fusicladium* Bonord. based on their morphological and phylogenetical affinities with *Venturiaceae* anamorphs. Among the remaining accepted species of *Anungitopsis*, *A. dimorphospora* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1991) is the most similar to *V. bispora*, particularly in having terminal, later intercalary conidiogenous cells with many flattened conidiogenous loci, and similarly shaped, polymorphic conidia in chains of two. However, *A. dimorphospora* has 3, rarely 4-euseptate conidia, with brown central cells, and subhyaline to colourless basal and apical cells.

The monotypic genus *Chikaneea* B. Sutton (Sutton 1973a), typified by *C. holleroniae* B. Sutton, also resemble *V. bispora* in conidial ontogeny and catenation, but the former has hyaline conidiophores, pale brown toward the base, with terminal conidiogenous cells and hyaline, cymbiform to long obovoid, guttulate, mostly 3 but occasionally 1–7-euseptate conidia disposed in fragmenting chains of at least two, where the lower conidium is invariably longer and with more septa that the upper.

Pleurotheciopsis B. Sutton (Sutton 1973b) also shows some similarity to *Veramycella* in having sympodial conidiogenous cells disposed on conidiophores with percurrent proliferations and acropetal, unbranched chains of conidia. However, *Pleurotheciopsis* differs in having euseptate conidia and denticulate conidiogenous loci, with short, cylindrical, unthickened denticles up to 1 µm diam., apical and closely arranged on the conidiogenous cell, but also inconspicuous and sloping in certain species such as *P. sylvestris* R.F. Castañeda & Iturr. or *P. tropicalis* R.F. Castañeda & M. Calduch, giving a rachiform appearance to the conidiogenous cell (Castañeda & Iturriaga 1999, Castañeda et al. 2001).

Another fungus, *Brevicatenospora enteroproliferata* R.F. Castañeda et al. (Castañeda et al. 2006), is comparable with *V. bispora* in having catenate, polymorphic conidia in chains of two, with primary and secondary conidia superficially resembling those of the latter. However, the conidia of *B. enteroproliferata* are one-celled, brown to red-brown, the primary conidia clavate, subclavate to slightly spathulate, and the secondary conidia obovoid, pyriform to subglobose in shape. They also differ in conidiogenesis, as *B. enteroproliferata* possess unilocal, annellidic conidiogenous cells with 10–28 enteroblastic, percurrent proliferations.

The distoseptate, subhyaline to pale olivaceous conidia of *V. bispora* are slightly reminiscent of those of some species of *Sporidesmiella* P.M. Kirk (Kirk 1982, Yanna et al. 2001, Wu & Zhuang 2005). Additionally, a few *Sporidesmiella* species, *S. aspera* Kuthub. & Nawawi, *S. brachysporioides* T.Y. Zhang & W.B. Kendr., *S. hyalosperma* var. *novae-zelandiae* (S. Hughes) P.M. Kirk, *S. pachyanthicola* W.B. Kendr. & R.F. Castañeda and *S. parva* var. *palauensis* Matsush., have rare or consistently sympodially proliferating conidiogenous cells (Kuthubutheen & Nawawi 1993, Zhang et al. 1983). However, *V. bispora* is not considered congeneric with the species mentioned above because their conidia are solitary, never in chains, and the addition of such a species having catenate conidia would unnecessarily broaden the already heterogeneous concept of *Sporidesmiella*.

Other hyphomycetes newly recorded from the continental USA

Brachyconidiella monilispora R.F. Castañeda & W.B. Kendr.,
University of Waterloo Biol. Ser. 33: 14, 1990. FIGS. 13–15

Conidiomata synnematal, scattered, erect, straight or flexuous, brown to olivaceous-brown, up to 190 µm tall, 11–44 µm wide at base, conidial heads 32–71 µm diam. Individual conidiophores unbranched, smooth, pale brown to brown, 2–3 µm wide. Conidiogenous cells monoblastic, terminal, integrated, cylindrical or barrel-shaped, 4–6 × 2–3 µm. Conidia cheirosporous, penicilliform, repeatedly branched, 16–23 × 12–24 µm, with up to 18 branches, each one composed of a chain of 5–9, hyaline to pale-olivaceous, subglobose to globose cells, 2–2.5 µm diam, basal cells subglobose to barrel-shaped, 3–4.5 µm diam.

SPECIMENS EXAMINED: Florida, Monroe Co., KEY LARGO, Key Largo Hammock Botanical State Park, on unidentified dead leaf, IV. 8. 2007, coll. G. Delgado (BPI 878833); on rotten dead stems, VII.20.2007 (BPI 878835).

The monotypic genus *Brachyconidiella* was introduced by Castañeda & Kendrick (1990), with *B. monilispora* as the type species, to accommodate a distinctive hyphomycete collected on decaying leaves of *Coccoloba uvifera* L. from Cuba. The genus is characterized by cheirosporous, penicilliform, repeatedly branched conidia arising from monoblastic, cylindrical or barrel-shaped conidiogenous cells disposed in unbranched conidiophores aggregated in synnemata or sporodochia. A preliminary phylogenetic analysis of small subunit (18S) rDNA sequence data did not clearly resolve the taxonomic placement of *B. monilispora* within the *Dothideomycetidae* (Decock et al. 2004). The present collection is the second time this anamorph is recorded since its original description. The Florida specimen has synnemata larger than those of the holotype (70–120 µm tall, 11–18 µm wide at base). No sporodochial conidiomata were observed.

Chloridium obclaviforme J. Mena & Mercado, Acta Bot. Hungarica 33: 76, 1987. FIG. 16

Conidiophores straight or flexuous, brown, paler toward the apex, 64–134 × 2.5–4 µm, 5–7 µm wide at base, tapering toward the apex in a funnel-shaped collarette, 2–3.5 µm wide, with up to 4 percurrent proliferations. Conidia aggregated in slimy heads, formed on a single conidiogenous locus, narrowly obclavate, aseptate, hyaline or subhyaline, smooth-walled, tapering toward the apex, obconical and papillate at base, 9–15 × 2–2.5 µm.

SPECIMEN EXAMINED: Florida, Miami Dade Co., NORTH MIAMI, Enchanted Forest Elaine Gordon Park, on petiole of dead leaf of *Sabal palmetto* (Walter) Lodd. ex Schult., VI. 30. 2007, coll. G. Delgado (BPI 878841).

Mena & Mercado (1987) first described *Chloridium obclaviforme* on dead branches of *Spondias mombin* L. and dead stems of *Bambusa* sp. from Cuba. The fungus is distinct among species of *Chloridium* Link by its conidial morphology, with narrowly obclavate conidia, tapered to the apex, obconical and papillate at base. Previously known only from the type locality, this is the second record of its occurrence worldwide. The morphological features of the Florida collection agree well with the original description, but conidiophores are slightly shorter (25–120 µm long in holotype). Matsushima (1993) described *Chloridium obclavatum* Matsush. from rotten petiole of *Arecaceae* in Peru, a very similar species with obclavate conidia but having conidiophores up to 260 µm and slightly larger conidia (6–18 × 2.5–4 µm), probably representing the same taxon.

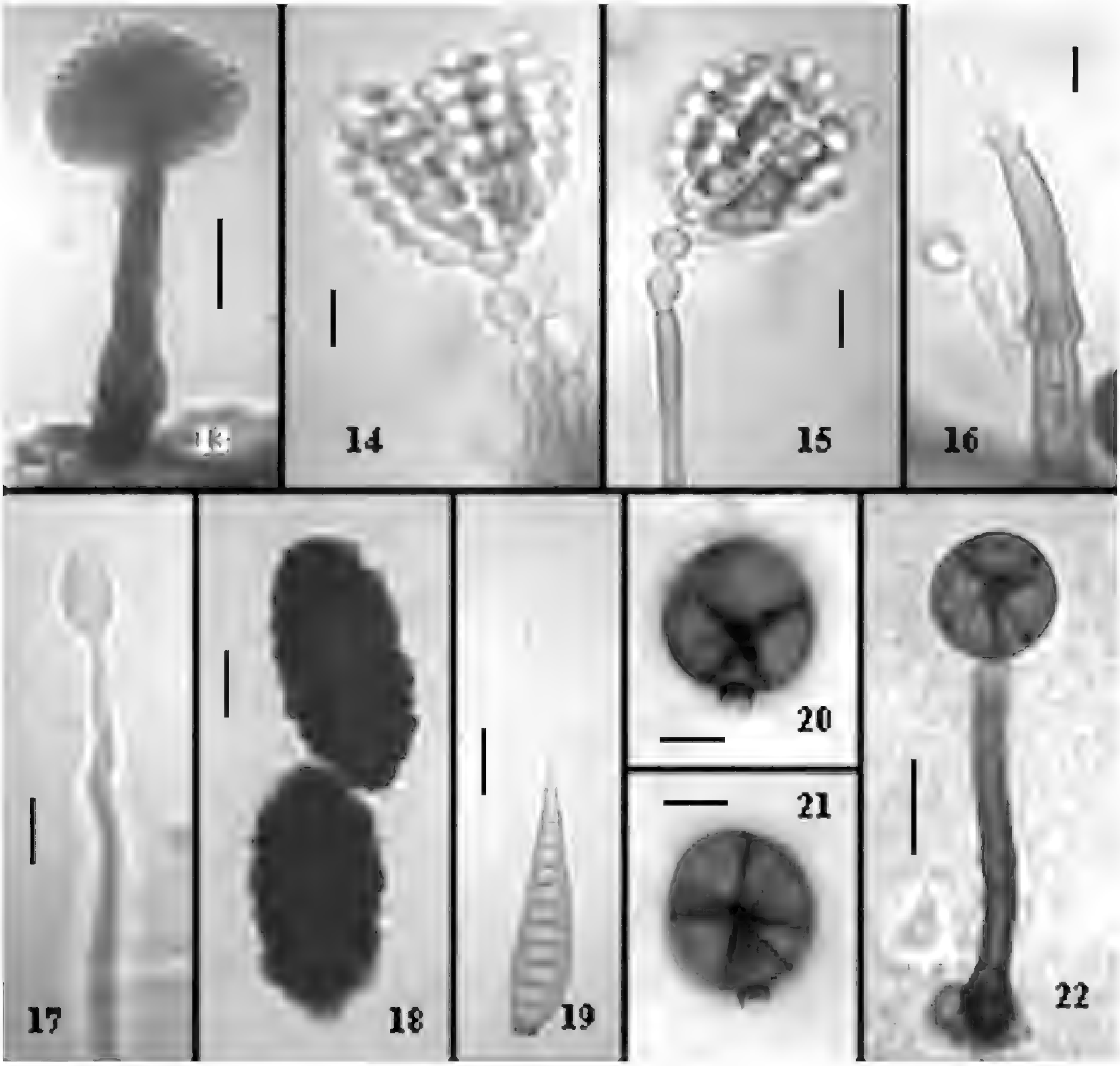
Coleodictyospora micronesica (Matsush.) Matsush., Matsush. Mycol. Mem. 5: 8, 1987. FIG. 30

≡ *Berkleasmium micronesicum* Matsush., Matsush. Mycol. Mem. 2: 2, 1981.

Colonies sporodochial, effuse. Conidia cylindro-ellipsoidal, muriform, smooth-walled, light brown, sometimes constricted in the middle, 29–40 × 15–18 µm, surrounded by a thick, hyaline, mucilaginous sheath.

SPECIMENS EXAMINED: Florida, Monroe Co., KEY LARGO, John Pennekamp Coral Reef State Park, on dead spathe and fragment of dead leaf of unidentified palm, VII. 20. 2007, coll. G. Delgado (BPI 878822, 878827).

Coleodictyospora micronesica was originally described in the genus *Berkleasmium* Zobel on dead petiole of *Cocos nucifera* L. from Guam (Matsushima 1981). It has been recorded also on barks of *Prestoea montana* (Graham) G. Nicholson, *Tectona grandis* L. f. and an undetermined plant from Puerto Rico (Cantrell et al. 2006), and is newly recorded here for the continental USA. The Florida collection agrees fairly well with the type specimen in morphology and conidial dimensions (30–40 × 13–16 µm).



Figs. 13–15. *Brachyconidiella monilispora* (BPI 878835). 13. Synnema. 14–15. Conidiogenous cells and conidia. **16.** *Chloridium obclaviforme* (BPI 878841). Conidiophore showing collarette and conidia. **17–18.** *Gliomastix fusigera* (BPI 878844). 17. Young conidium attached to the conidiophore. 18. Conidia. **19.** *Ellisembia flagelliformis* (BPI 878843). Conidium. **20–22.** *Rhexoacrodictys martinii* (BPI 878843). 20–21. Conidia. 22. Conidiophore with attached conidium. Scale bars: 13 = 30 µm, 19, 22 = 10 µm; 14–18, 20-21 = 5 µm.

Ellisembia flagelliformis (Matsush.) W.P. Wu, in Wu & Zhuang, *Sporidesmium, Endophragmiella* and related genera from China: 127, 2005. Fig. 19

≡*Sporidesmium flagelliforme* Matsush., Icon. Microfung. Matsush. Lect.: 137, 1975.

Conidiophores cylindrical, straight or flexuous, brown, 22–65 × 4–6 µm, with 0–2 doliiform percurrent proliferations. Conidia obclavate or ellipsoidal, rostrate, straight or slightly curved, 11–16-distoseptate, golden brown to brown, paler toward the apex, 61–89 × 8–10 µm; apical appendage filiform, 0–1-septate, up to 71 µm, 1–2 µm wide; basal cell conico-truncate, darker, 3–4 µm wide.

Specimens examined: Florida, Miami Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachides and petiole of dead leaf of *Sabal palmetto* (Walter)

Lodd. ex Schult., VI. 30. 2007, coll. G. Delgado (BPI 878836, 878838 878841, 878842); IX.22.2007 (BPI 878843).

Wu & Zhuang (2005) recently transferred *Sporidesmium flagelliforme* to the genus *Ellisembia* Subram. (Subramanian 1992), based on the combination of distoseptate conidia and conidiophores with or without percurrent proliferations. It was originally isolated from forest soil in Japan (Matsushima 1975), and subsequently recorded on a dead trunk of *Euphorbia* sp. in Cuba (Holubová-Jechová & Mercado 1989), on dead culms of bamboo in China (Wu & Zhuang 2005), on decomposing leaves of *Caesalpinia echinata* Lam. in Brazil (Da Silva 2007) and now for the first time in USA.

Endophragmiella fallacia P.M. Kirk, Trans. Br. Mycol. Soc. 77: 286, 1981. Figs. 26–27

Colonies effuse, hairy. Conidiophores cylindrical, erect, straight or slightly flexuous, brown, paler toward the apex, 127–243 × 4–6 µm, 7–10 µm at base. Conidiogenous cells integrated, terminal, cylindrical, smooth, with 2–4 percurrent proliferations. Conidia oblong to broadly ellipsoidal, (1–)2-euseptate, brown, the basal cell paler, smooth, 15–26 × 8–11 µm, apex rounded, base truncate, with a distinct basal frill, 1–2 µm long.

Specimen examined: Florida, Miami Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachides and petioles of dead leaf of *Sabal palmetto* (Walter) Lodd. ex Schult., VI. 30. 2007, coll. G. Delgado (BPI 878836).

The presence of (1–)2-euseptate, broadly ellipsoidal to cylindrical conidia, with the upper two cells brown, the basal cell paler and a distinct basal frill, distinguish *E. fallacia* from other similar *Endophragmiella* B. Sutton species (Kirk 1981). Wu & Zhuang (2005) cited two specimens on dead branches of *Betula pendula* Roth and *Quercus robur* L. from China with 2–3-euseptate conidia. The Florida collection is consistent with the holotype from U.K in having mostly 2, sometimes 1-euseptate conidia, but they are slightly narrower compared with the original specimen, (9–)10–12(–13) µm wide. This is the first record of *E. fallacia* in North America and the third time is recorded worldwide, previously known only from U.K. and China.

Gliomastix fusigera (Berk. & Broome) C.H. Dickinson, Mycol. Pap. 115: 7, 1968. Figs. 17–18

≡ *Monotospora fusigera* Berk. & Broome, J. Linn. Soc., Bot. 14: 99, 1873.

≡ *Acremonium fusigerum* (Berk. & Broome) W. Gams, Cephalosporium-artige Schimmelpilze: 94, 1971.

Conidiophores unbranched, erect or flexuous, hyaline, smooth, 45–79 × 2–3.5 µm, up to 4 µm at base. Conidia ellipsoidal, dark brown to black, verrucose, 14–22 × 5–8 µm.

Specimen examined: Florida, Miami Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachis of dead leaf of *Sabal palmetto* (Walter) Lodd. ex Schult., VI. 30. 2007, coll. G. Delgado (BPI 878844).

G. fusigera apparently has a widespread distribution, mainly in tropical and subtropical areas. It has been previously recorded in Bangladesh, Cuba, Dominican Republic, Hong Kong, Japan, Malaysia, New Caledonia, New Zealand, Philippines, Seychelles, Sri Lanka, Taiwan (Hyde et al. 2002, Mercado et al. 1997, Minter & Perdomo 2006, Herb IMI on-line undated) and now for the first time in USA. The generic concept of *Gliomastix* sensu Dickinson (1968) is applied here to accommodate this fungus with dark, pigmented conidia, instead of the treatment as a section of the genus *Acremonium* Link (Gams 1971).

Henicospora coronata B. Sutton & P.M. Kirk, in Kirk & Sutton, Trans. Br. Mycol. Soc. 75: 249, 1980. Fig. 25

= *Trichocladium elegans* R.F. Castañeda & G.R.W. Arnold, Rev. Jard. Bot. Nac. 6: 52, 1985.

= *Trichocladium singaporense* Tubaki, T.K. Tan & Y. Ogawa, Mycotaxon 46: 438, 1993.

Conidia cylindrical, smooth, pale olivaceous-brown, coronate at the apex, with 3 dark transverse eusepta and 2 hyaline distosepta, 20–27 × 3.5–4.5 µm. Conidial secession rhexolytic.

Specimens examined: Florida, Monroe Co., Key Largo, Key Largo Hammock Botanical State Park, on unidentified dead leaves, IV. 8. 2007, coll. G. Delgado (BPI 878830, 878832).

While first describing *Henicospora coronata*, Kirk & Sutton (1980) recorded three specimens on dead leaves of *Eucalyptus saligna* Sm. and *Eucalyptus* sp. from Hawaii and American Samoa. This is the first record of *H. coronata* for the continental USA.

Monodictys desquamata K. Rodr., Figueras & Guarro, in Rodríguez et al., Nova Hedwigia 72: 203, 2001. Fig. 29

Colonies effuse, black. Conidia muriform, ellipsoidal or subglobose, dark brown, 53–114 × 38–84 µm; superficial cells protruding from the conidial wall, subglobose to irregular, pale brown, 3–7 × 3–7.5 µm.

Specimen examined: Florida, Miami Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on petiole of dead leaf of *Sabal palmetto* (Walter) Lodd. ex Schult. VI. 30. 2007, coll. G. Delgado (BPI 878841).

M. desquamata is distinct in having dark brown, muriform conidia with conspicuous, subglobose to irregular external cells that easily detach from the conidial wall (Rodríguez et al. 2001). This is the second time this fungus has been recorded worldwide, originally described from a fallen bark of an undetermined tree in Cuba. The Florida collection has conidia larger than those of the type specimen (33–102 × 32–72 µm).

Myrothecium setiramosum R.F. Castañeda, Deuteromycotina de Cuba. Hyphomycetes IV: 10, 1986. FIG. 23

Conidiomata sporodochial, pulvinate, mucous, green to blackish green. Setae cylindrical, straight, hyaline, smooth, dichotomously or irregularly branched at the apex, 95–154 × 2.5–3.5 µm. Conidia fusiform, aseptate, smooth, hyaline or very pale green, 7–10 × 1–1.5 µm, with 0–2 guttules.

SPECIMEN EXAMINED: Florida, Monroe Co., KEY LARGO, John Pennekamp Coral Reef State Park, on unidentified dead leaf, VII. 20. 2007, coll. G. Delgado (BPI 878825).

M. setiramosum is known mainly from tropical countries, including records from Brazil, Cuba, Mexico, Nigeria, Singapore (Castañeda et al. 2002a, Heredia et al. 2006) and now for the first time from the subtropical region of Florida. It is distinguished from other species of *Myrothecium* Tode by the presence of apically branched, hyaline, smooth setae and cylindrical to fusiform conidia. The type specimen, originally described from fallen leaves of *Eugenia glabrata* (Sw.) DC. in Cuba (Castañeda 1986), have larger setae than the present specimen (100–300 µm).

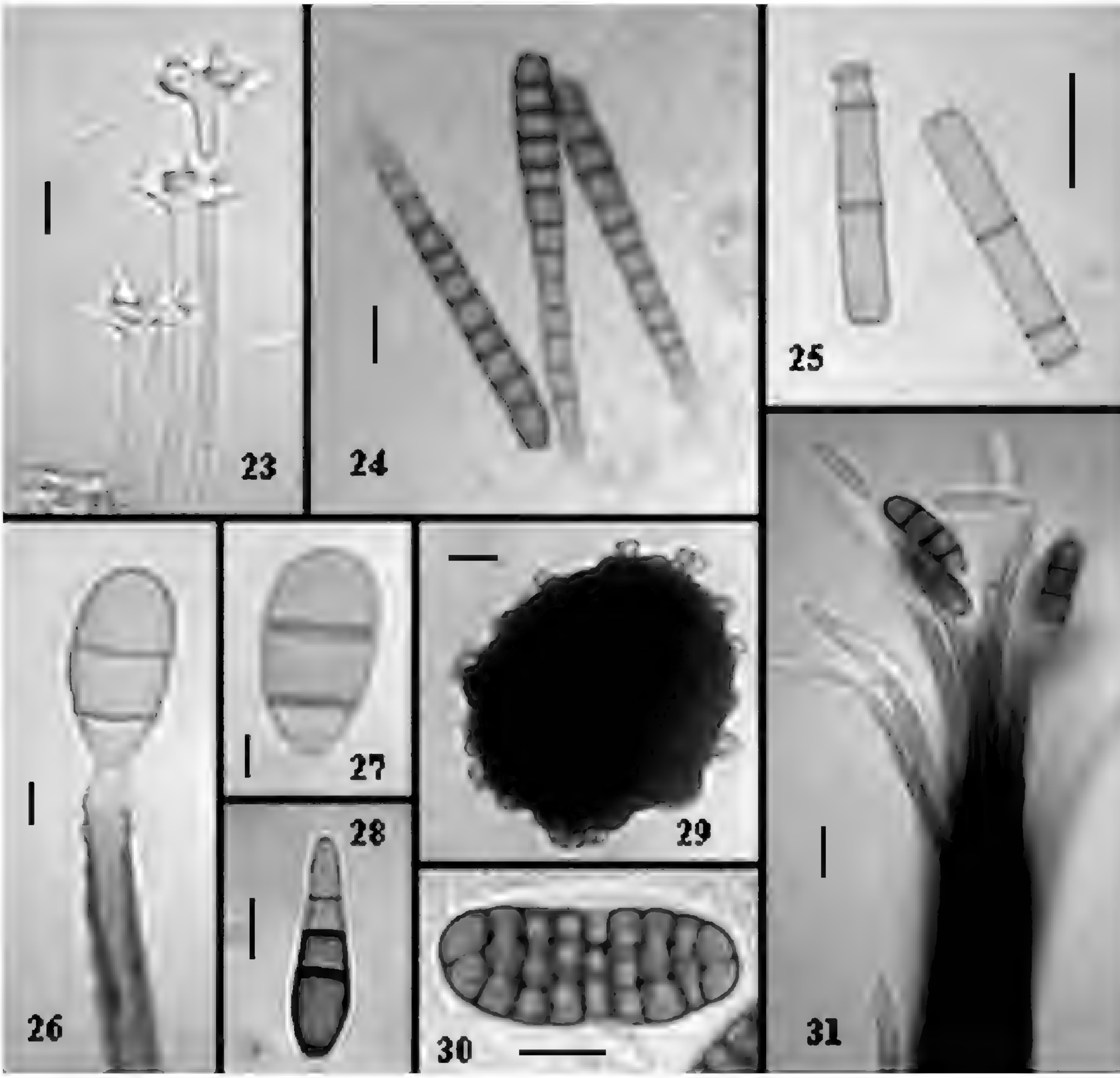
Phaeoisaria triseptata Hol.-Jech., Česká Mykol. 42: 27, 1988. FIG. 31

≡ *Helicomina triseptata* (Hol.-Jech.) R.F. Castañeda, Guarro & Saikawa, Cryptog. Mycol. 23: 16, 2002.

Colonies effuse, hairy, brown. Conidiophores caespitose to synnematous, straight or flexuous, brown, paler toward the apex, synnemata up to 612 µm, 29–55 µm wide at base. Conidiogenous cells polyblastic, integrated, terminal but sometimes intercalary, denticulate, smooth, 22–35 × 2.5–3 µm, denticles cylindrical, 2–3 µm long. Conidia ellipsoidal to clavate, 3-euseptate, straight or slightly curved, brown, the basal cell often paler, 17–22 × 5–7 µm.

SPECIMEN EXAMINED: Florida, Monroe Co., KEY LARGO, Key Largo Hammock Botanical State Park, on rotten dead stems, VII. 20. 2007, coll. G. Delgado (BPI 878835).

Castañeda et al. (2002b) considered this anamorph not congeneric with the accepted concept of *Phaeoisaria* Höhn., and transferred it to *Helicomina* L.S. Olive (Olive 1948). However, Deighton (1976) had previously treated *Helicomina* as a synonym of *Pseudocercospora* Speg., and his judgment has been accepted by others (Pons & Sutton 1988, Zhao et al. 2007). The present collection is the first record of its occurrence in the continental United States, previously found on bark of *Tectona grandis* L. f. from Puerto Rico (Cantrell et al. 2006). The type specimen, which was originally collected on a dead branch of an undetermined tree from Cuba (Holubová-Jechová 1988), has synnemata considerable larger than the Florida specimen (600–1800 µm).



Figs. 23. *Myrothecium setiramosum* (BPI 878825). 23. Setae. **24.** *Sporidesmium pachyanthicola* (BPI 878838). Conidia. **25.** *Henicospora coronata* (BPI 878832). Conidia. **26–27.** *Endophragmiella fallacia* (BPI 878836). 26. Conidiophore and attached conidium. 27. Conidium. **28.** *Sporidesmium angustiobpyriforme* (BPI 878828). Conidium. **29.** *Monodictys desquamata* (BPI 878841). Conidium. **30.** *Coleodictyospora micronesica* (BPI 878822). Conidium. **31.** *Phaeoisaria triseptata* (BPI 878835). Apex of a synnema and conidia. Scale bars: 23–25, 29–31= 10 µm, 26–28 = 5 µm.

Rhexoacrodictys martinii (J.L. Crane & Dumont) G. Delgado, **comb. nov.**

MycoBank MB512671 Figs. 20–22

Basionym: *Acrodictys martinii* J.L. Crane & Dumont, Can. J. Bot. 53: 846, 1975.

≡ *Junewangia martinii* (J.L. Crane & Dumont) W.A. Baker & Morgan-Jones, Mycotaxon 81: 310, 2002.

Conidiophores cylindrical, straight or flexuous, brown, paler toward the apex, 42–116 × 3–4 µm, 5–7 µm wide at the base, with 0–2 percurrent proliferations. Conidia globose, subglobose or broadly ellipsoidal, pale brown to brown, cruciately septate but sometimes with a few transverse, longitudinal or oblique septa, 11–16 µm diam, conidial secession rhexolytic.

Specimen examined: Florida, Miami Dade Co., North Miami, Enchanted Forest Elaine Gordon Park, on rachides of dead leaf of *Sabal palmetto* (Walter) Lodd. ex Schult., IX.22.2007, coll. G. Delgado (BPI 878843).

This fungus was originally described as *Acrodictys martinii* on rotten bark and wood from Puerto Rico (Crane & Dumont 1975) and is first recorded here for the continental USA. It was characterized then by having globose, mostly cruciately septate conidia and cylindrical conidiophores, 116–522 µm long, 8.9–11 µm wide at base. Baker et al. (2002a) transferred it later to *Junewangia* W.A. Baker & Morgan-Jones, a genus segregated from *Acrodictys* M.B. Ellis to include species with percurrent proliferating conidiophores, cylindrical or narrowly cuneate conidiogenous cells and oval, subspherical to almost spherical conidia seceding schizolytically, with a truncate, protuberant basal cell. However, a rhexolytic detachment process apparently occurs in this fungus instead of a schizolytic secession. Most conidia bear a distinct marginal frill derived from the upper portion of the conidiophores, or in very few cases, a short, terminal conidiophore cell is attached. This feature is typical of *Rhexoacrodictys* W.A. Baker & Morgan-Jones, another genus segregated from *Acrodictys* (Baker et al. 2002b), and therefore a new combination is proposed above. Matsushima (1993) recorded a specimen on decaying twigs of broad-leaved tree in Peru, and illustrated a similar disarticulation process. The specimen studied here has shorter conidiophores compared with the holotype from Puerto Rico, which are considerable longer and probably extreme (up to 522 µm), while those of the Peruvian specimen are also shorter (25–50 µm). Whitton et al. (2000) described a close species, *J. lamma* (Whitton et al.) W.A. Baker & Morgan-Jones (≡ *A. lamma* Whitton et al.), with slightly different conidial septation and shorter conidiophores (14–57 × 2.5–4 µm), considering possible they were both the same taxon. However, the conidia of *J. lamma* bear a persistent, pale brown, protruding, cylindrical basal cell, 3.2–5 µm diam., apparently seceding schizolytically, and consequently it is satisfactorily placed in *Junewangia* as a separated taxon.

Sporidesmium angustiobpyriforme Matsush., Matsush. Mycol. Mem. 7: 67, 1993. Fig. 28

Conidiophores solitary or in groups, simple, cylindrical, straight or slightly flexuous, smooth, brown, 35–86 × 3–4 µm, 5–6 µm at base, with 0–2 cylindrical to lageniform, light brown to brown percurrent proliferations, 10–21 × 3–4 µm. Conidia narrowly obclavate, (2–)3(–4)-euseptate, brown, apical cells paler, 12–23 × 4–5 µm.

Specimen examined: Florida, Monroe Co., Key Largo, John Pennekamp Coral Reef State Park, on unidentified dead twigs, VII. 20. 2007, coll. G. Delgado (BPI 878828).

S. angustiobpyriforme was initially described on a rotten petiole of unidentified *Arecaceae* in Peru (Matsushima 1993), and later on dead branches of woody plants in China (Wu & Zhuang 2005). The Florida collection is the third time the fungus is recorded worldwide and its first record in North America.

Sporidesmium pachyanthicola R.F. Castañeda & W.B. Kendr., University of Waterloo Biol. Ser. 33: 45, 1990. FIG. 24

Conidiophores cylindrical, straight or slightly flexuous, brown, 1–7-septate, 14–34 × 4–5 µm, up to 6 µm at base, without percurrent proliferations. Conidia narrowly obclavate or subcylindrical, 6–31-euseptate, brown, becoming paler toward the apex, 32–172 × 3–5 µm, base truncate, apex rounded, basal cell conico-truncate.

SPECIMENS EXAMINED: Florida, Miami Dade Co., NORTH MIAMI, Enchanted Forest Elaine Gordon Park, on rachides and petiole of dead leaves of *Sabal palmetto* (Walter) Lodd. ex Schult., VI. 30. 2007, IX.22.2007, coll. G. Delgado (BPI 878836, 878838, 878841, 878843); Florida, Monroe Co., KEY LARGO, John Pennekamp Coral Reef State Park, on unidentified dead bark, VII. 20. 2007, coll. G. Delgado (BPI 878824).

Since its original description from dead leaves of *Pachyanthus poiretii* Griseb. in Cuba (Castaneda & Kendrick 1990), *S. pachyanthicola* has been recorded also on dead branches of *Eucalyptus* sp. in China (Wu & Zhuang 2005) and now for the first time in North America. The Florida specimens have larger conidia and shorter conidiophores compared with the holotype from Cuba (conidia 50–140 µm long, conidiophores 30–75 µm tall).

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New records of two crustose sorediate lichens from central Europe

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Abstract — *Halecania viridescens* is reported for the first time for Poland, and *Lepraria granulata* is new to Poland and Slovakia. Both species belong to a group of sterile lichens where secondary chemistry plays an important role in the taxonomy. Taxonomic descriptions and comments are provided.

Key words — lichenized fungi, chemotaxonomy, lichen metabolites, geographical distribution

Introduction

Sorediate crustose lichens are one of the weakly studied groups in central and eastern central Europe. Most records are based only on morphological characters with chemistry not checked by thin layer chromatography, making the reports frequently unreliable. Although some species are quite well studied, they represent easy-to-determine taxa or lichens that often produce both apothecia and vegetative diaspores like soredia. Recently several new reliable records of sorediate crustose lichens have been published from many regions (e.g. Schreiner & Hafellner 1992, Tønsberg 1992, Śliwa & Tønsberg 1995, Motiejūnaitė et al. 2003, Prigodina-Lukošienė et al. 2003, Czarnota & Kukwa 2004, 2007, Kukwa 2005, Kukwa & Motiejūnaitė 2005, Boom & Palice 2006, Kukwa & Kubiak 2007), but many are still known only from a few localities. Within the group, the genus *Lepraria* Ach. seems to be the best studied (e.g. Kukwa 2001, 2006, Bayerová & Kukwa 2003, Bayerová 2006), but still the knowledge is far from satisfactory, as taxa new to science are still being discovered (Bayerová et al. 2005, Slavíková-Bayerová & Orange 2006, Slavíková-Bayerová & Fehrer 2007). The other similar case is *Ochrolechia* A. Massal., which at present is thoroughly studied in Poland (Jabłońska & Kukwa 2007, Kukwa 2008).

In this paper we further contribute to the knowledge of sorediate lichens from central Europe. Two taxa are reported. The first, *Halecania viridescens*, is a

rather inconspicuous species that, when sterile, is difficult to determine without experience. The second species, the recently described *Lepraria granulata,* is thus far known from only a few localities.

Material and methods

All cited material (including types) is housed in the following herbaria: BG, BM, E, KRAM and UGDA. Duplicates of *Halecania viridescens* have been donated to GPN and KRAM. Chemical analyses were performed by thin-layer chromatography (TLC in solvent A, B and C) according to the methods of Orange et al. (2001). When a lichen substance was always present it is marked with '(+)', but if the metabolite was absent from some specimens, '(±)' is used.

The taxa

Halecania viridescens Coppins & P. James, in Coppins, Lichenologist 21: 224. 1989.

Description: Thallus corticolous, epiphloeodal, areolate, areoles scattered to contiguous, rounded, convex, fragile, mostly dissolved into soralia; soralia numerous, up to ca. 0.2 mm diam., punctiform, discrete to confluent in places, sometimes forming small patches of leprose crust, vivid-green to brow green due to the pigmentation of outer soredia; soredia farinose, internal green, external usually with brown pigment, often shed and than exposing the inner soredia; apothecia not found in Polish material. For the detailed description see Coppins (1989a) and Tønsberg (1992).

Chemistry: The following substances were detected in the specimens studied: argopsin (+), norargopsin (±), unknown substance [i.e., 'gracilenta unknown 1' (+), see Tønsberg 1992] with an additional related substance in minor amount in Rf classes B3, C5 (±; not observed in solvent A) and unknown pigment in Rf class C2–3 (±; found only once, but also detected in Polish material of *Biatora efflorescens* (Hedl.) Räsänen, another lichen producing argopsin). In general our results agree with Coppins (1989a) and Tønsberg (1992).

Ecology — *Halecania viridescens* was found in habitats with high humidity that are influenced by human impact. It was growing on free standing trees surrounded by meadows, at the edge of or inside of managed forests, always in river valleys. Associated lichens species included typical species inhabiting roadsides or free standing trees: *Amandinea punctata* (Hoffm.) Coppins & Scheid., *Bacidia adastra* Sparrius & Aptroot, *B. naegelii* (Hepp) Zahlbr., *Caloplaca obscurella* (J. Lahm ex Körb.) Th. Fr., *Candelariella* spp., *Lecania cyrtella* (Ach.) Th. Fr., *Lepraria* sp., *Parmelia sulcata* Taylor, *Phaeophyscia orbicularis* (Neck.) Moberg, *Physcia* spp., and *Physconia* spp.

Geographical distribution — The species is quite rarely reported but rather widely distributed. It is known from Austria (Berger & Türk 1993), British Isles (Coppins 1989a), Czech Republic (Boom & Palice 2006), Norway (Tønsberg 1992), France and Spain (Boom et al. 1995), Portugal (Aptroot et al. 1992), Slovakia (Guttová & Palice 2001), and Sweden (Ekman & Arup 2000). Outside Europe it has been reported from Pacific Northwest in North America (Tønsberg 1994), Guatemala in central America (Boom et al. 2007), and the Canary Islands in Africa (Tønsberg 2002a). Here it is reported as new to Poland. The record from Pieniny Mts is also only the second report for the entire Carpathian range.

Comments — The species is predominantly characterized by small, usually discrete soralia (often with a brown pigment in the external soredia) and the presence of argopsin and 'gracilenta unknown 1' (Coppins 1989a, Tønsberg (1992). When sterile, *Halecania viridescens* is morphologically similar to *Rinodina efflorescens* Malme and *R. griseosoralifera* Coppins, both of which also develop brownish, external soredia. The latter two taxa can be easily separated from *H. viridescens* chemically: *R. efflorescens* contains pannarin and zeorin as major secondary compounds (Tønsberg 1992, Kowalewska & Kukwa 2003), whereas R. *griseosoralifera* produces atranorin and zeorin (Coppins 1989b, Czarnota & Kukwa 2007). Usually all three species lack apothecia (in Poland only *R. efflorescens* was very rarely found with fruit bodies), but if fertile, they also differ in the type of spores. *Halecania viridescens* produces hyaline, thin-walled spores, often covered with a gelatinous epispore, whereas both *Rinodina* species develop brown spores with ±thick walls and without an epispore (Coppins 1989a, b; Tonsberg 1992).

Argopsin, the major lichen substance present in *Halecania viridescens*, is also known in four sorediate species of *Biatora*, namely *B. bacidioides* Printzen & Tønsberg, *B. britannica* Printzen et al., *B. efflorescens* and *B. printzenii* Tønsberg. They may be mistaken for *Halecania viridescens* (Tønsberg 1992, 2002b, Printzen & Tønsberg 2003) but differ predominantly chemically, as no *Biatora* species contains 'gracilenta unknown 1'; additionally, *B. bacidioides* and *B. printzenii* produce gyrophoric acid. When fertile, all taxa can be separated by apothecial type: *Halecania viridescens* develops lecanorine apothecia with entirely sorediate margins, whereas the apothecia of all *Biatora* species lack a thalline margin (Coppins 1989a; Tønsberg 1992, 2002b; Printzen & Tønsberg 2003). So far only *B. britannica* and *B. efflorescens* are known from Europe, and only the latter from Poland and adjacent areas.

Specimens examined — **POLAND. Iława Lakeland.** N part of Nowa Wieś village, by Postolińska Struga stream, on *Salix* sp.—02.11.2004, M. Kukwa 3592 & 3600 (UGDA–L–14244 & 14340, GPN, KRAM). Ca. 0.5 km NNW of Nowa Wieś village, on *Salix* sp.—02.11.2004, M. Kukwa 3605 (UGDA–L–14341). **Wschodniosuwalskie**

Lakeland. Turtul settlement, Czarna Hacza river valley, 54°13'19"N/22°48'35"E, on *Salix fragilis*—09.07.2006, M. Kukwa 5772 (UGDA–L–14293). **Kaszubskie Lakeland.** Dolina Ewy valley, 54°24'31"N/18°31'45"E, on *Sambucus nigra*—04.04.2004, M. Kukwa 2990 (UGDA–L–14242). **Western Carpathians: Pieniny Mts.** Pieniński National Park, S of Krościenko village, along Dunajec river, 49°25'55"N, 20°26'15"E, on *Salix* sp.—02.05.2008, M. Kukwa 5956b (UGDA–L–14686).

Reference material examined (selected)—**GREAT BRITAIN. Scotland: Dunbarton (V.C. 99).** Loch Lomond NNR, Shore Wood, by shore of lake, on *Salix* sp.—05.09.1980, B.J. Coppins 8212 (isotype-E). South side of River Lyon, downstream of Bridge of Balgie, 200 m, on *Populus tremula*—19.06.2004, C.J. Ellis, B.J. Coppins (E). **NORWAY. Hordaland:** Bergen, Tertnes, UTM 32V KN 9808, 60 m, on *Aesculus hippocastanum*—23.08.1992, T. Tønsberg 17763 (BG L–25552).

Lepraria granulata Slavíková, in Slavíková-Bayerová & Fehrer, Lichenologist 39: 321. 2007.

Description: Thallus granular, white to grey, ± with a faint bluish tinge, delimited with obscure marginal lobes or diffuse; hyphae below the thallus scarce, greyish (pale yellowish orange-brown hyphae, as cited in the protologue, were not observed); soredia coarse, up to ca 200 µm, projecting hyphae not observed. For a more detailed description see Slavíková-Bayerová & Fehrer (2007).

Chemistry: Atranorin (+), fatty acid called 'granulata unknown 1' (see Slavíková-Bayerová & Fehrer 2007) and an unidentified pigment (anthraquinone; ±) were detected. Slavíková-Bayerová & Fehrer (2007) report an additional fatty acid — 'granulata unknown 2' — as a common accessory substance that was not detected in our examined specimens.

Ecology — *Lepraria granulata* was found on saxicolous mosses or directly on siliceous rocks in open and rain-exposed sites at high elevations. In Polish collections no accompanying species were noted. The Slovak specimen grew together with *L. borealis* Loht. & Tønsberg (chemotype with angardianic/roccellic acid; see Prigodina-Lukošienė et al. 2003).

Geographical distribution — *Lepraria granulata* has been reported so far from Austria, Bulgaria and the Czech Republic (Slavíková-Bayerová & Fehrer 2007). Here it is reported as new to Poland and Slovakia. The Polish record was previously misidentified as *L. borealis*, but re-examination of two *L. borealis* samples kept in UGDA suggest that they represent *L. granulata*. Because a true *L. borealis* still occurs in the same ATPOL grid square, the Kukwa (2006) distribution map fortunately does not need to be updated.

Comments — There are several *Lepraria* species with similar thallus organization (granular, usually grayish thallus, in many samples with obscure lobes) and ecology (the occurrence on rain-exposed habitats), which form the

so-called *Lepraria neglecta* group (Leuckert et al. 1995, Ekman & Tønsberg 2002, Tønsberg 2004, Slavíková-Bayerová & Fehrer 2007). As the morphology in all concerned taxa is actually identical, the secondary chemistry remains the best reliable and useful character to discriminate all species. In the past some doubts existed if such a character can be sufficient for the recognition of the taxa at species level, or if only chemotypes of a single species should be distinguished. However, recent molecular studied showed that the species are genetically different. The problem appeared to be more complicated as even the chemotypes of *L. caesioalba* (B. de Lesd.) J.R. Laundon did not form a monophyletic group (Ekman & Tønsberg 2002). It seems to us that those chemical strains can be recognized at the species level, but that needs further studies. Molecular analyses also confirmed the taxonomic importance of fatty acids in the species recognition (Ekman & Tønsberg 2002, Slavíková-Bayerová & Fehrer 2007), which was sometimes put into question as well (e.g. Laundon 1992). Recently Slavíková-Bayerová & Fehrer (2007) defined the group more precisely as the *L. neglecta* core group, and added also two, still not formally described taxa with a more leprose thallus.

Lepraria granulata is differentiated from other species with granular thalli only by the presence of the fatty acid 'granulata unknown 1' (sometimes with 'granulata unknown 2'). The substance is not known in any other *Lepraria* species, except the undescribed '*Lepraria* sp. G' (see Slavíková-Bayerová & Fehrer 2007). The latter taxon differs in the thallus morphology, which is leprose and more similar to *L. humida* Slavíková & Orange than *L. granulata* (Slavíková-Bayerová & Orange 2006, Slavíková-Bayerová & Fehrer 2007). Other morphologically similar species can be distinguished by the presence of different fatty acids (roccellic and rangiformic acids in *L. borealis* and one unnamed taxon; see Ekman & Tønsberg 2002), production of alectorialic acid [*L. neglecta* (Nyl.) Erichsen] or porphyrilic acid [*L. alpina* (B. de Lesd.) Tretiach & Baruffo], or the occurrence of several depsidones, like fumarprotocetraric acid, stictic acid, and psoromic acid (*L. caesioalba* with 3 to 5 chemotypes) (Laundon 1992, Tønsberg 1992, 2004; Lohtander 1994, Baruffo et al. 2006, Slavíková-Bayerová & Fehrer 2007).

Specimens examined—**POLAND. Western Carpathians: High Tatra Mts.** Tatra National Park, Krzyżne, side from Dolina Roztoki valley, by the yellow tourist path, 1820 m, 49°13'3"N/20°02'45"E, on saxicolous mosses—09.08.2003, P. Czarnota s.n. (UGDA–L–10504 & 11011). **SLOVAKIA. Western Carpathians: High Tatra Mts.** Tatra National Park, N of Štrbské Pleso town, Furkotská valley, on rocks—16.081999, M. Kukwa s.n. (UGDA–L–6928).

Reference material examined—**BULGARIA. Rita Mts.** Rila National Park, by the marked path from the hut Rilski ezera to the hut Sedemte ezera, c. 600 m, W of lake Dolnoto ezero, 42°12'47"N, 23°19'10"E, on mosses, 22.06.2004—Š. Bayerová 3237, M. Slavík (**duplicate of paratype**-UGDA–L–14309, ex herb. Slavíková-Bayerová).

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MYCOTAXON

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New species of *Digitoramispora* and *Spondylocladiopsis* from the forests of Western Ghats, India

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Abstract – Two new species of hyphomycetes, *Digitoramispora tambdisurlensis* and *Spondylocladiopsis aseptata,* isolated from decaying plant litter collected from the Western Ghat forests of Tambdi Surla in Goa State, and Calicut in Kerala State, India, respectively, are described and illustrated.

Key words – biodiversity, anamorphic fungi, taxonomy, tropical forests

Introduction

During the course of studies on microfungi from forests of Western Ghats in southern India, two hitherto undescribed dematiaceous hyphomycete species, belonging to the genera *Digitoramispora* R.F. Castañeda & W.B. Kendr. and *Spondylocladiopsis* M.B. Ellis, were isolated from fallen and decaying plant litter. These fungi are described and illustrated.

Taxonomic descriptions

Digitoramispora tambdisurlensis Pratibha, Raghuk. & Bhat, **sp. nov.** Figs. 1, 2

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Ad fungos conidiales, hyphomycetes. Coloniae in substrato naturalis dispersae, atrobrunneae vel nigrae; mycelium partim superficialia, partim substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis, septatis, 2–3 μm latis compositum. Stroma nullus. Coloniae in PDA-cultura irregulares, atro viridiae, gossypinus, reverses nigrae, margine serratus, diam. 2.2 cm aetate 10 dierum. Conidiophora mononematica, singula, erecta, recta vel leviter flexuosa, non-ramosa, atrobrunnea, aliquando prolongata, 22–320 × Cellulae conidiogenae monoblasticae, integratae, terminales, cylindricae vel lageniformes, 10–17.5 × 5–10 μm. Conidia muriformis, forma variabilia, saepe dorsiventraliter applanata, flabelliformis, atrobrunnea in centrum cum ramis peripheralis pallide brunnea, 50–90 × 40–75 μm.

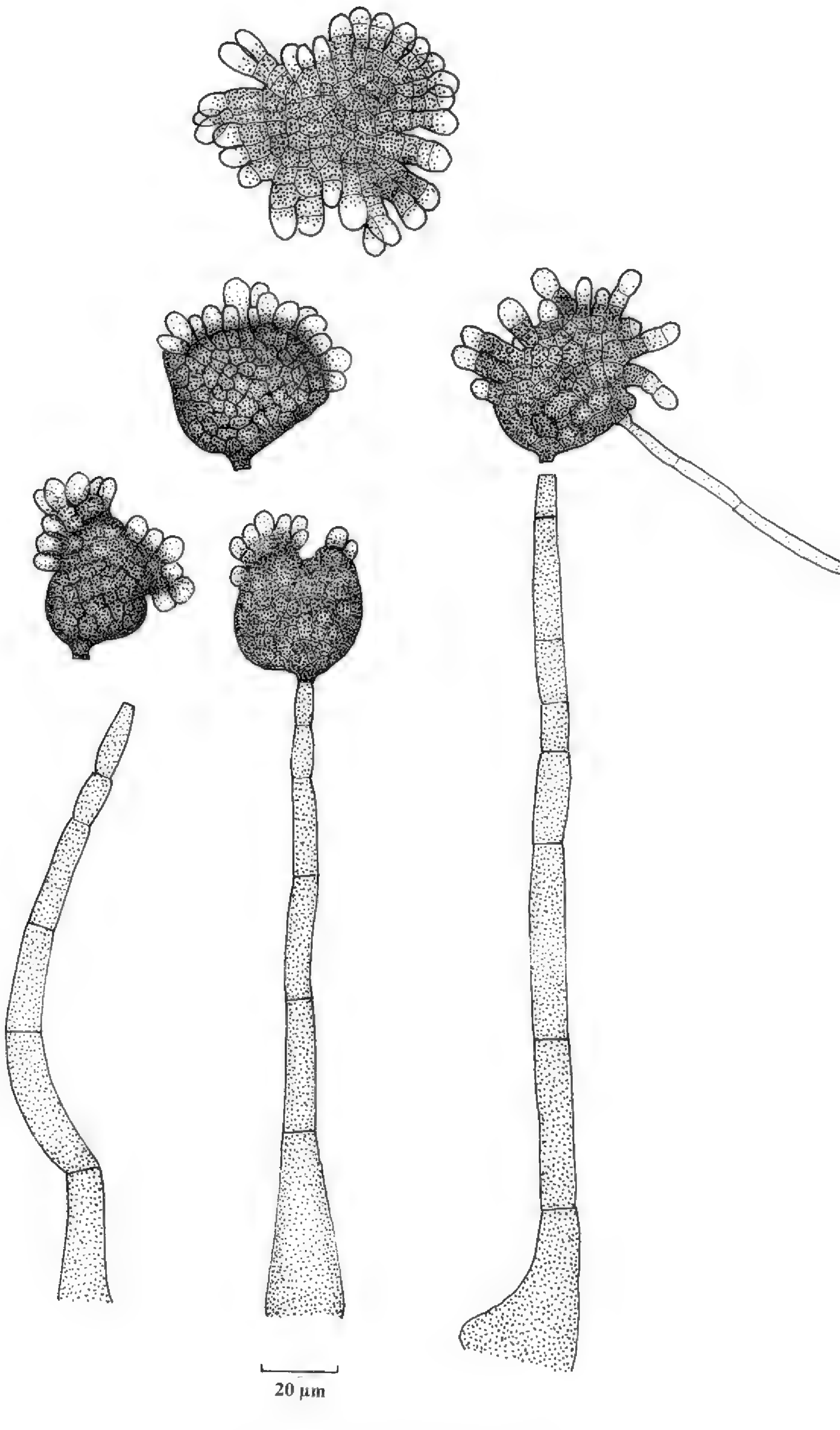

Fig. 1. ***Digitoramispora tambdisurlensis.***
Conidiophores and conidia.

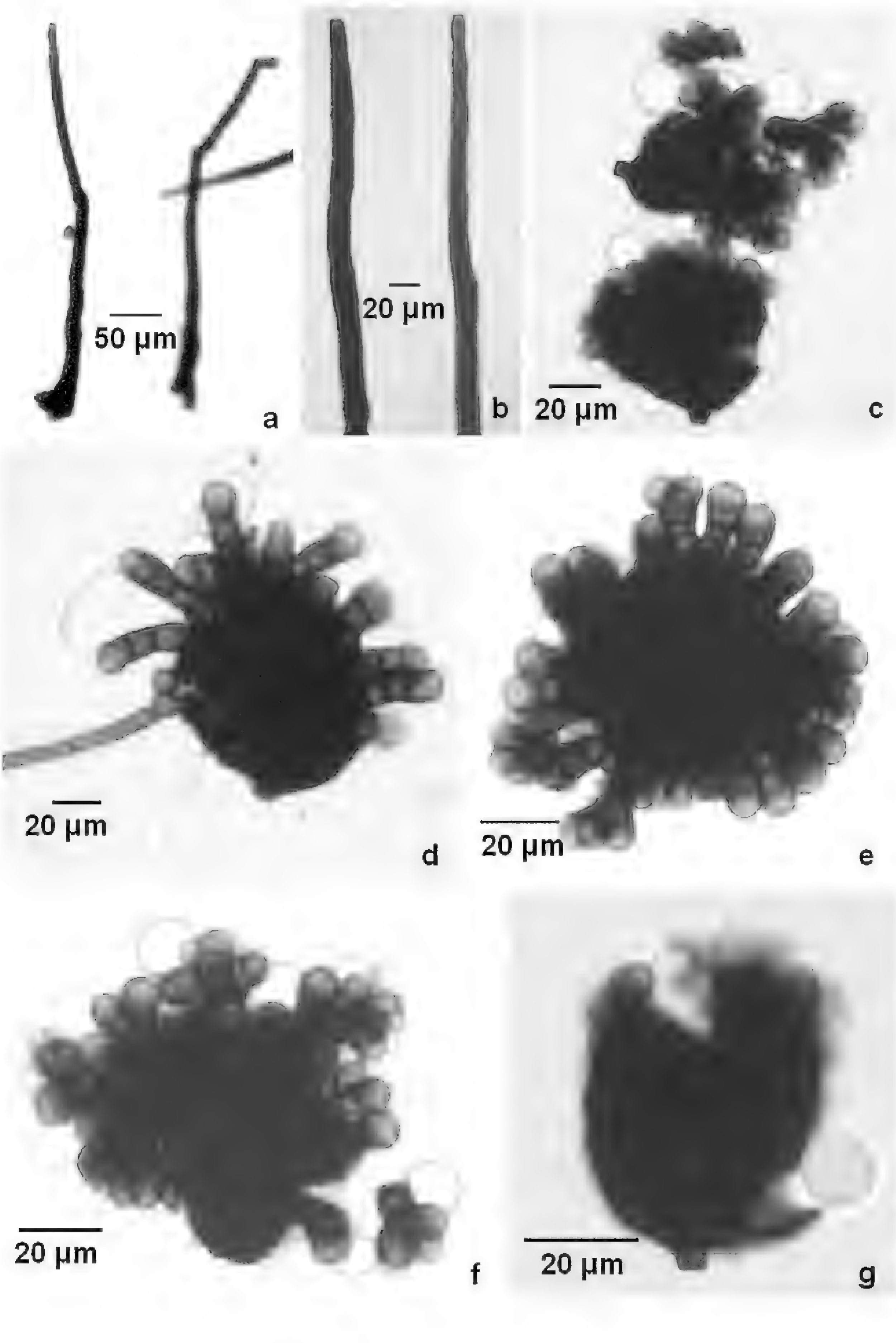

Fig. 2. ***Digitoramispora tambdisurlensis.***
a–b. Conidiophores; c–g. Conidia.

HOLOTYPE: On unidentified dead twig, 27.VII.2008, col. J. Pratibha, Tambdi Surla, Goa, India, Herb. No. HCIO 48773.

Conidial fungi, hyphomycetes. Colonies on natural substrate scattered, dark brown to black; mycelium partly superficial, partly immersed in the host tissue, composed of smooth, light brown, branched, septate hyphae, 2–3 µm wide. Colonies on PDA irregular, dark green, cottony, reverse black, margin serrated, attaining a diam. of 2.2 cm in 10 days at 25°C. Stroma none. Setae and hyphopodia absent. Conidiophores differentiated, single, erect, straight to slightly flexuous, unbranched, dark brown, sometimes extending, 220–320 × 7–15 µm. Conidiogenous cells monoblastic, integrated, terminal, cylindrical to lageniform, 10–17.5 × 5–10 µm. Conidia muriform or cheiroid, variable in shape, dorsiventrally flattened, fan-shaped, dark brown in the centre with peripheral light brown cells, 50–90 × 40–75 µm.

NOTES: The genus *Digitoramispora* was established by Castañeda & Kendrick (1990) to accommodate two species: *D. caribensis* R.F. Castañeda & W.B. Kendr. and *D. excentrica* (B. Sutton) Castañeda & W.B. Kendr., with the former as type species. *D. excentrica* was originally described as *Acrodictys excentrica* B. Sutton and later transferred to *Arachnophora excentrica* (B. Sutton) S. Hughes. Subsequently, a third species has been accommodated in *Digitoramispora*, *D. lageniformis* Somrith. & E.B.G. Jones (Somrithipol & Jones 2003). The genus is characterized by pigmented, dictyosporous or sometimes cheiroid conidia with peripheral, hyaline or paler brown, short radiating branches (or cells) and irregularly, though often percurrently, extending conidiophores (Castañeda & Kendrick 1990). *D. tambdisurlensis* differs from the other three species in its much larger conidia and conidiophores (TABLE 1).

TABLE 1. Synopsis of *Digitoramispora.*

SPECIES	CONIDIOPHORES	CONIDIA
D. caribensis	Extending percurrently, 20–55 × 5–6 µm	Central cells brown to black, distal cells hyaline to subhyaline, 15–20 × 10–15 µm
D. excentrica	Extending percurrently, 70–175 × 5–7 µm	Central cells blackish brown, distal cells pale brown, 13–18 × 12–17 µm
D. lageniformis	Extending percurrently, lageniform to ovoid, 105–150 × 6–6.5 µm	Central cells brown, distal cells hyaline to subhyaline, 37–45 × 28–32 µm
D. tambdisurlensis	Extending irregularly or percurrently, 220–320 × 7–15 µm	Central cells dark brown, distal cells pale brown, 50–90 × 40–75 µm

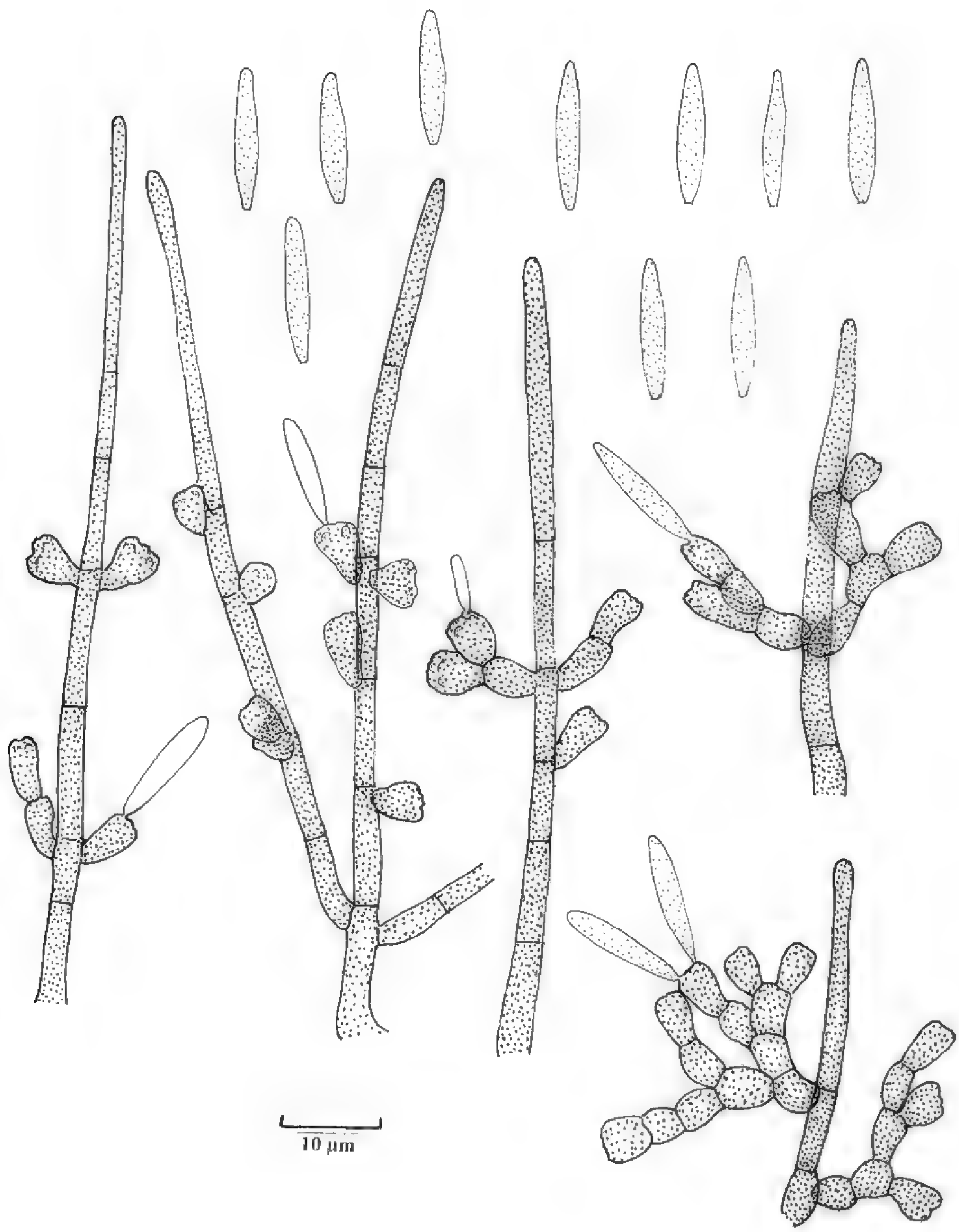

Fig. 3. ***Spondylocladiopsis aseptata***.
Conidiophores with conidiogenous cells and conidia.

Spondylocladiopsis aseptata Pratibha, Raghuk. & Bhat, **sp. nov.** Figs. 3, 4

MycoBank MB 512673

Ad fungos conidiales, hyphomycetes. Coloniae in substrato naturalis effusae, pallide brunneae, velutinae; mycelium partim superficialia, partim substrato immersum, ex hyphis laevibus, pallide brunneis, ramosis, septatis, 2–2.5 µm latis compositum. Coloniae in PDA-cultura circularis ad semicircularis, atro viridiae, planus, reverses nigrae, margine serratus, diam. 2.0 cm aetate 10 dierum. Stroma nullus. Setae absentia, conidiophora apicem sterilis et setiformis. Hyphopodia absentia. Conidiophora macronematica, mononematica, erecta, recta vel flexuosa, septata, laevia, ramosus ad basim, brunneae ad basim, terminans cum pallide brunnea to sub-hyalinae sterilis apicem, 45–115 × 2.5–5 µm. Cellulae conidiogenae polyblasticae, portatus directus in conidiophora vel in 1–4 sustinens cellulae, discretae, denticulatae, pallide brunneae, 4.5–8 × 3–6 µm. Conidia sicca, solitaria, laevia, sub-

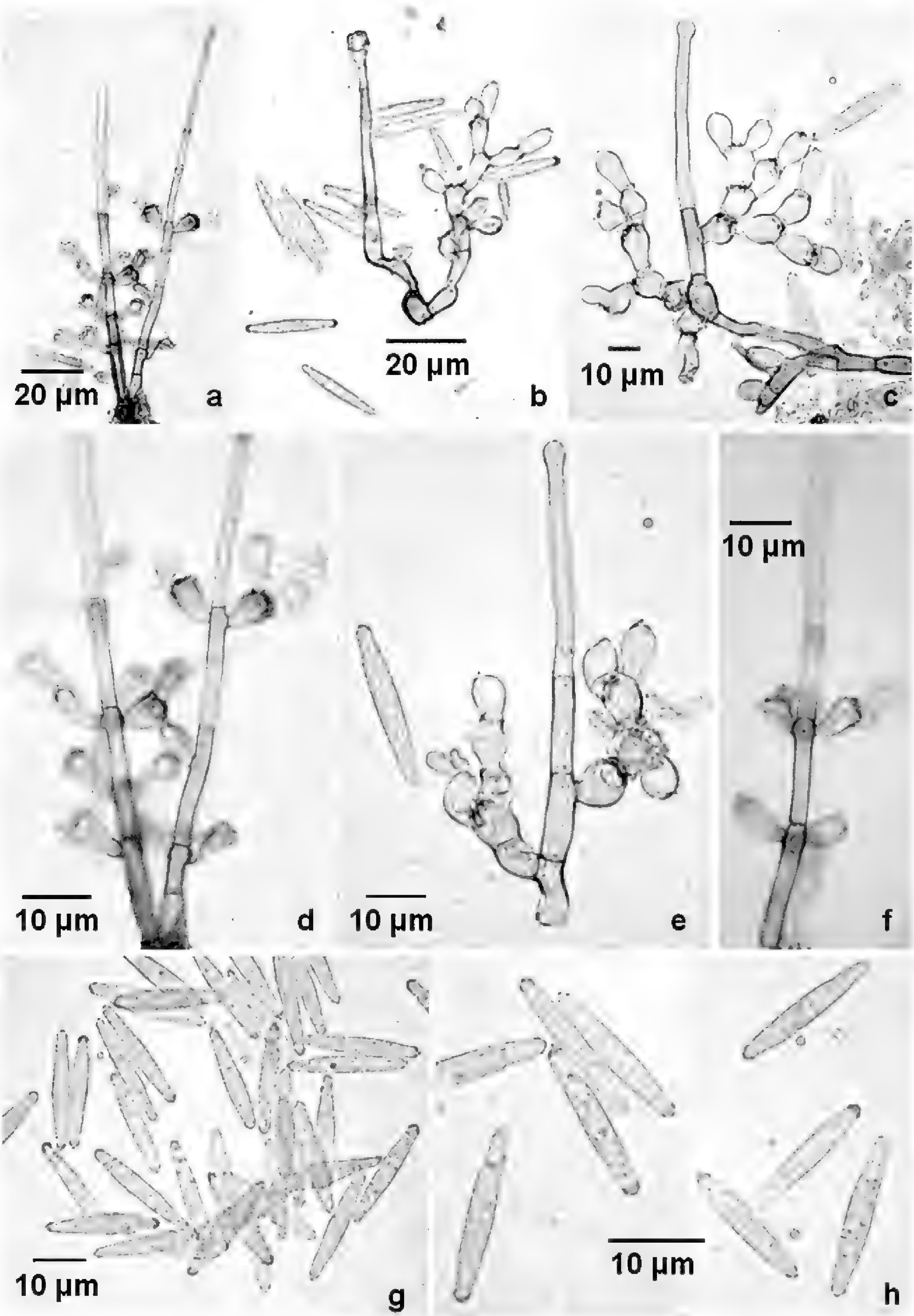

FIG. 4. *Spondylocladiopsis aseptata.*
a–f. Conidiophores with polyblastic conidiogenous cells; g–h. Aseptate conidia.

hyalina, 0-septata, cylindrica vel fusiformis, rotundatus ad utrinque extrema, 13.5–23 × 2–4 µm.

HOLOTYPE: On leaf litter, 29.VIII.2008, col. J. Pratibha, Calicut, Kerala, India, Herb. No. HCIO 48774.

Conidial fungi, hyphomycetes. Colonies on natural substrate effuse, light brown, velvety; mycelium partly superficial, partly immersed in the host tissue, composed of smooth, light brown, branched, septate, 2–2.5 µm wide hyphae. Colonies on PDA circular to semi-circular, dark green, flat, reverse black, margin serrated, attaining a diam. of 2 cm in 10 days at 25 °C. Stroma none. Setae absent, but apex of the conidiophores sterile and setiform. Hyphopodia absent. Conidiophores differentiated, single, erect, straight to flexuous, septate, smooth, branched at the basal region, medium brown below, with a light brown to sub-hyaline, sterile apex, 45–115 × 2.5–5 µm. Conidiogenous cells polyblastic, discrete, borne directly on the conidiophore or on short branches of 1–4 supporting cells, denticulate, light brown, 4.5–8 × 3–6 µm. Conidia dry, solitary, smooth, sub-hyaline, 0-septate, cylindrical to fusiform, rounded at both ends, 13.5–23 × 2–4 µm.

NOTES: The genus *Spondylocladiopsis,* with *S. cupulicola* M.B. Ellis as type species, was established by Ellis (1963) to accommodate fungi with polyblastic, discrete conidiogenous cells arranged in pairs or verticils on setiform conidiophores. Until now, the genus has been monotypic (Ellis 1971). *S. aseptata* differs from the type species by formation of aseptate conidia and conidiogenous cells developed on basal [supporting] cells borne on the conidiophore. The conidia in *S. cupulicola* are 2-septate and conidiogenous cells are directly borne on conidiophores (TABLE 2).

TABLE 2. Synopsis of *Spondylocladiopsis.*

SPECIES	CONIDIOPHORES	CONIDIOGENOUS CELLS	CONIDIA
S. cupulicola	≤ 310 µm long, 6–8 µm thick at base	Borne directly on conidiophores, 5–10 µm long, 2–3.5 µm at base, 3.5–8 µm at apex	Cylindrical, 2-septate, 18–23 × 3–4 µm
S. aseptata	45–115 × 2.5–5 µm	Borne directly on conidiophores or with 1–4 supporting cells, 4.5–8 µm long, 3–3.5 µm at base, 3.5–6 µm at apex	Cylindrical to fusiform, 0-septate, 13.5–23 × 2–4 µm

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Five lichens of the genus *Lecanora* new to China

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Abstract—Five new records from China, *Lecanora argentea*, *L. imshaugii*, *L. nipponica*, *L. novae-hollandiae, L. subrugosa* are reported. Photos of their thalli are provided.

Key words—*Lecanoraceae*, Asia, taxonomy

Introduction

The lichen genus *Lecanora (Lecanoraceae)* was originally established by Acharius (1810), distinguished by its crustose thallus with apothecia having thalline tissue containing algal cells. The genus was subsequently restricted by Massalongo (1852) and it was maintained for species with simple, colourless spores of moderate size. Now, *Lecanora* is defined by asci of the *Lecanora*-type, simple, colourless ascospores, and crustose thalli; the apothecial margin usually contains algal cells (Ryan et al. 2004). *Lecanora* sensu stricto is characterized by the presence of oxalate crystals in the amphithecium and the production of atranorin and/or usnic acid in the cortex (LaGreca & Lumbsch 2001).

Worldwide, *Lecanora* (sensu stricto) includes about 300 known species (LaGreca & Lumbsch 2001). In China, this genus (sensu lato) includes 93 species. During our study of *Lecanora* sensu stricto in China, five new records were discovered, namely *Lecanora argentea*, *L. imshaugii*, *L. nipponica*, *L. novae-hollandiae* and *L. subrugosa*.

Material and methods

The specimens studied are housed in SDNU (Lichen Section of Botanical Herbarium, Shandong Normal University) or HMAS-L (Lichen Section, Herbarium of the Institute of Microbiology, Academia Sinica). Thalli were examined and measured under a stereo-microscope (COIC XTL7045B2) and

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apothecial anatomy was observed under a polarizing microscope (OLYMPUS CX41-32). Photos of the thalli were taken with an OLYMPUS SZX12 with DP70. Lichen substances were identified using the standardized thin layer chromatography techniques of Culberson (1972).

The new records

1. ***Lecanora argentea*** Oxner & Volkova,
Nov. Sist. Niz. Rast. 1966: 283 (1966) FIGURE 1A
= *Lecanora fuliginosa* Brodo, Beih. Nova Hedw. 79: 124. 1984.

Thallus whitish gray to yellowish gray, dispersed-verrucose to verruculose, margin definite, prothallus white. Apothecia sessile, 0.6–1.8 mm in diam., discs black brown to black, epruinose, margins concolorous with thallus, even, smooth. Amphithecium: cortex distinct, basally thickened, 20–25 µm laterally, 35–50 µm at base, containing large crystals insoluble in KOH. Epihymenium brown black, not turning green in KOH, without crystals, 10–20 µm tall. Hymenium hyaline, 52.5–70 µm tall, paraphyses slightly thickened. Hypothecium hyaline, 50–100 µm thick. Ascospores simple, hyaline, broadly ellipsoid, 8–15 × 5–8 µm.

CHEMISTRY: atranorin, gangaleoidin.

SUBSTRATE: saxicolous.

COMMENTS — This species is characterized by the saxicolous, crustose thallus, brown-black to black apothecial discs, a clear, egranulose epihymenium, an amphithecium containing large crystals and the presence of gangaleoidin. *Lecanora gangaleoides* is morphologically and chemically similar but differs in having a greenish black epihymenium in KOH. *Lecanora argentea* is also similar to *L. cenisia*, but the latter lacks gangaleoidin and has a coarse granular epihymenium.

L. argentea was described from the former Soviet Union and has been reported from North America and Asia (Brodo 1984, sub *L. fuliginosa*, Ryan et al. 2004). New to China.

SPECIMENS EXAMINED: **CHINA. Shannxi:** Mt. Taibaishan, fangyangsi, alt. 3300m, on rock, 4 Aug. 2005, C.L. Wang & F. Yang, TBW405 (SDNU); **Jilin:** Yanji City, Wangqing Country, Tianqiaoling Town, tulaopoding, alt. 1035m, on rock, 1 Dem. 2007, C. Yuan & L.Y. Sun, 20073428 (SDNU).

2. ***Lecanora imshaugii*** Brodo, Beih. Nova Hedwigia 79: 137 (1984). FIGURE 1B
= *Lecanora perflexuosa* (Räsänen) H. Miyaw., J. Hattori Bot. Lab. 64 : 320. 1988.

Thallus yellowish grey, thick, verruculose, margin definite, prothallus absent. Apothecia sessile, crowded, (0.3–)0.5–1.5 mm in diam., discs deep reddish brown, epruinose, margins pale yellowish white, usually whiter than thallus,

smooth, prominent, becoming flexuous. Amphithecium: cortex indistinct to absent, 10µm thick when distinguishable, containing small crystals insoluble in KOH. Epihymenium yellowish to reddish brown, containing coarse granules, (7.5–)10–12.5 µm tall. Hymenium hyaline, 50–60 µm tall. Hypothecium hyaline, 60 µm thick. Ascospores simple, hyaline, ellipsoid, 9–16 × 6–7.5 µm.

Chemistry: atranorin, zeorin.

Substrate: corticolous.

Comments — This species is characterized by the corticolous, verruculose thallus, crowded, sessile apothecia, flexuous, dull apothecial margins lacking any cortex, an amphithecium containing small crystals insoluble in KOH, and the presence of zeorin. In lacking a cortex it is only similar to *L. perplexa* which also contains zeorin, but the amphithecium of *L. perplexa* contains large crystals and the thallus is often granulose.

L. imshaugii was described from North America (Brodo 1984) and is also known from Japan (Miyawaki 1994). New to China.

Specimens examined: CHINA. **Gansu**: Diebu country, Laolonggou, alt. 2400m, on bark, 27 Jul. 2005, X.L. Shi & F. Yang, 060711 (SDNU); **Liaoning**: Kuandian country, Baishilizi Nature Reserve, alt. 407m, on bark, 19 Jul. 2000, J.C. Wei & M.R. Huang, 030792 (HMAS-L); Kuandian country, Baishilizi Nature Reserve, Fotanggou, alt. 650m, on bark, 11 Jul. 2000, J.C. Wei & M.R. Huang, 030796 (HMAS-L).

3. ***Lecanora nipponica*** H. Miyaw., J. Hattori Bot. Lab. 64: 296 (1988) Figure 1c

Thallus yellowish white to yellowish gray, moderately thick, verruculose, margin indistinct, prothallus absent. Apothecia sessile, generally crowded, 0.7–2.2 mm in diam., discs reddish brown to deep brown, epruinose, margins concolorous with thallus, entire to verrucose. Amphithecium: cortex 10–25 µm thick, algae cells abundant, containing large crystals insoluble in KOH. Epihymenium yellowish to reddish brown, containing coarse granules, 10–20 µm tall. Hymenium hyaline, 75–100 µm tall. Hypothecium hyaline, 70–125 µm thick. Ascospores simple, hyaline, ellipsoid, (8–)12.5–15(–20) × 6–12.5 µm.

Chemistry: atranorin.

Substrate: corticolous.

Comments — This species is characterized by the corticolous, verruculose thallus, the prominent apothecial margin, the coarse granular epihymenium, and an amphithecium containing large crystals insoluble in KOH. It is similar to *L. novae-hollandiae* in verruculose thallus, prominent apothecial margin and having coarse granular epihymenium but differs in lacking pannarin

Lecanora nipponica was previously known only from Japan (Miyawaki 1988). New to China.

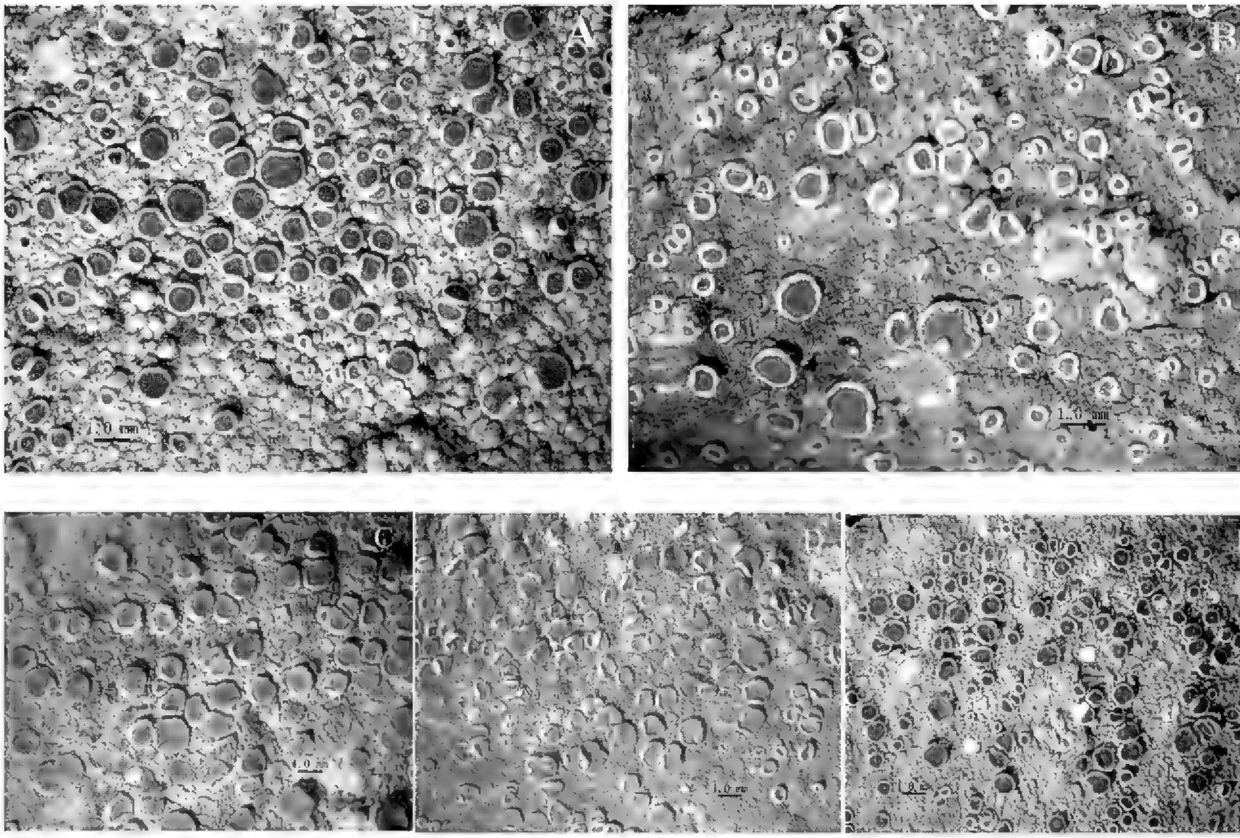

FIGURE 1 *Lecanora* species examined in the present study. Scale bar = 1 mm. A. *Lecanora argentea*, TBW405 C.L. Wang & F. Yang (SDNU); B. *Lecanora imshaugii*, 060711 X.L. Shi & F. Yang (SDNU); C. *Lecanora nipponica*, 033033 X.Y. Wang et al. (HMAS-L); D. *Lecanora novae-hollandiae*, 030787 M.R. Huang (HMAS-L); E. *Lecanora subrugosa*, 060641 Z.F. Jia (SDNU)

SPECIMENS EXAMINED: CHINA. **Yunnan**: Lushui Country, Pianmatingming Lake, alt. 3500m, on bark, 2 Jun. 1981, X.Y. Wang et al., 033033 (HMAS-L); **Shannxi**: Mt. Taibaishan, Shangbaiyun, alt. 1650m, on bark, 1 Aug. 2005, Y.J. Li & W. Fu, L398 (SDNU).

4. *Lecanora novae-hollandiae* Lumbsch,
J. Hattori Bot. Lab. 77: 118 (1994) FIGURE 1D

Thallus yellowish gray, with a rough verrucose surface, margin definite, prothallus gray or absent. Apothecia sessile, 0.5–2.0 mm in diam., discs yellowish to reddish brown, epruinose, margins concolorous with the thallus, entire, smooth or crenulate. Amphithecium: cortex hyaline, uniform, 15–25 μm thick, containing large crystals insoluble in KOH. Epihymenium yellowish to reddish brown, with abundant coarse granules, (7.5–)10–17.5(–22.5) μm tall. Hymenium hyaline, 47.5–62.5 μm tall. Hypothecium hyaline, 25–47.5 μm thick. Ascospores simple, hyaline, broadly ellipsoid, 9–13(–16) × (4.5–)6–9.5μm.

CHEMISTRY: atranorin, pannarin, minor: chloroatranorin, dechloropannarin, methyl-virensate, argopsin.

SUBSTRATE: corticolous.

COMMENTS — This species is characterized by the corticolous, verruculose thallus, pale red-brown apothecial discs, the coarse granular epihymenium, an amphithecium containing large crystals and the presence of pannarin. It is somewhat similar to *L. cinereofusca*, but the latter contains placodiolic acid and its epihymenium pigment dissolves in KOH (Lumbsch & Elix 2004).

L. novae-hollandiae has been reported from Australia and New Zealand (Lumbsch & Elix 2004). New to China.

SPECIMENS EXAMINED: **CHINA.Anhui**: Jinzhai country, Tiantangzhai, alt. 800m, on bark, 11 Sep. 2001, M.R. Huang, 030787 (HMAS-L); **Gansu**: Zhouqu country, Huacaopoxigou, alt. 3300m, on wood, 29 July 2006, X.L. Shi & F. Yang, 060939 (SDNU).

5. *Lecanora subrugosa* Nyl., Flora 58: 15 (1875) FIGURE 1E

Thallus white grey to yellowish grey, verruculose or dispersed verrucose, margin definite, prothallus absent. Apothecia sessile or constricted at base, (0.3–) 0.8–1.7(–2.0) mm in diam., discs reddish brown to dark brown, epruinose, shiny, margins concolorous with the thallus, thick, verruculose. Amphithecium: with large crystals insoluble in KOH, cortex hyaline, inspersed, distinct or decomposed and becoming indistinct, 15–30 μm laterally, up to 40 μm at base. Epihymenium red-brown, lacking granules, 5–15 μm tall. Hymenium hyaline, 50–100 μm tall. Paraphyses slightly thickened. Hypothecium hyaline, 50–75 (–100) μm thick. Ascospores simple, hyaline, broadly ellipsoid, 6.5–12.5 × 4.5–7.5 μm, walls 0.8–1.0 μm thick.

CHEMISTRY: atranorin.

SUBSTRATE: corticolous.

COMMENTS — This species is characterized by the corticolous, verruculose thallus, large apothecia with reddish brown discs and coarsely verrucose apothecial margins, egranulose epihymenium and lack of other substances in addition to atranorin. It is similar to *L. rugosella* morphologically, but the latter species has a granulose epihymenium. It is also similar to *L. argentata*, but the latter contains gangaleoidin. Some European collections of *L. subrugosa* contain gangaleoidin (Brodo 1984, Ryan et al. 2004), but specimens from China examined by us do not contain this substance.

Lecanora subrugosa has been reported from North America, Africa, and Europe (Brodo 1984, Ryan et al. 2004). New to China.

SPECIMENS EXAMINED: **CHINA.Gansu**: Diebu country: Mogou, alt. 2780m, on bark, 26 Jul. 2006, Z.F. Jia 060641 (SDNU); Wen country: Qiujiaba, alt. 2400m, on bark, 3 Aug. 2006, C.L. Wang & L. Lü, 061843-3 (SDNU); **Shannxi**: Mt. Taibaishan, Shangbaiyun, alt. 1700m, on bark, 1 Aug. 2005, S.X. Guo & X.L. Shi, QL570 (SDNU); Ningshan country, Baiyangling, alt. 1700m, on bark, 28 Jul. 2005, S.X. Guo & X.L. Shi, SH297-1 (SDNU); **Yunnan**: Lijiang country, Mt. Yulongxueshan, Shanzifeng, alt. 3400m, on bark, 5 Aug. 1981, X.Y. Wang et al., 033093 (HMAS-L).

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Dimastigosporium yanense, a new coprophilous fungus from the forests of Western Ghats in Karnataka State, India

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Abstract — *Dimastigosporium yanense* sp. nov., isolated from cattle dung collected from the forests of Western Ghats, Karnataka State, India, is described and illustrated. *D. yanense* differs from the genus type species, *D. musimonum*, by the production of subcylindrical, smaller conidia with an apical and three basal appendages. The conidia develop holoblastically through one of the basal appendages.

Key words — biodiversity, anamorphic, coelomycete, pure culture.

Introduction

During studies on the biodiversity and taxonomy of microfungi of the forests of Western Ghats in southern India, an interesting coelomycete fungus was collected and isolated from partially decomposed cow dung. It was collected at Yana, a tiny hamlet amidst dense and pristine tropical forests, 30 km from Kumta, Uttara Kannada District, Karnataka State, India. Description and taxonomy of the fungus form the subject matter of this communication.

Materials and methods

The dung sample was air-dried and taken to the laboratory in paper bags. A small lump was soaked in sterile distilled water and incubated for several days in a sterile plastic box lined with moist filter paper. The dung was examined under a stereoscope at periodic intervals. Fungal fructifications appeared after 10 days of incubation. A pure culture of the fungus was established by streaking a sterile needle tip-full of conidia on malt extract agar (HiMedia, India) containing antibiotics (bacitracin, 0.02 g; neomycin, 0.02 g; penicillin, 0.02 g; streptomycin, 0.02 g; tetramycin, 0.02 g; dissolved in 10 ml of distilled water) and then purified by transferring germinated individual conidia onto malt extract agar slants.

Taxonomic description

Dimastigosporium yanense S.K. Yadav & Bhat, **sp. nov.** FIGURES 1–7

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Coloniae lente crescentes in agaro extracto malti, mucosae, pallide aurantiae, 3.5 mm diam. post 20 dies 22–24°C. Conidiomata primum clausa, deinde dehiscentia et cupularia, 250–450 µm diam., 500–750 µm alta, viridi-brunnea; stratum basilare pseudoparenchymatosum; paries pycnidiorum plectenchymatosus, setis conspicuis, rectis vel curvatis, crassitunicatis, laevibus, septatis, raro ramosis, usque 220 µm longis et 7 µm latis praeditus. Conidiophora in hymenio aggregated, hyalina, laevia, septata, in parte inferiore ramosa, 6–23 × 2–3.5 µm. Cellulae conidiogenae holoblasticae, cylindricae, sursum angustatae, laeves, integratae, determinatae, 6.5–20 × 1–5 µm. Conidia subcylindrica, hyalina, aseptata, solitaria, numerosa, aggregata pallide aurantia, tenuitunicata, laevia, 6.5–10 × 1.5–2.5 µm, una appendice apicali et tribus basilaribus praedita; appendices non-cellulares, hyalinae, non ramosae, laeves, 10–16 µm longae, ad 1 µm latae.

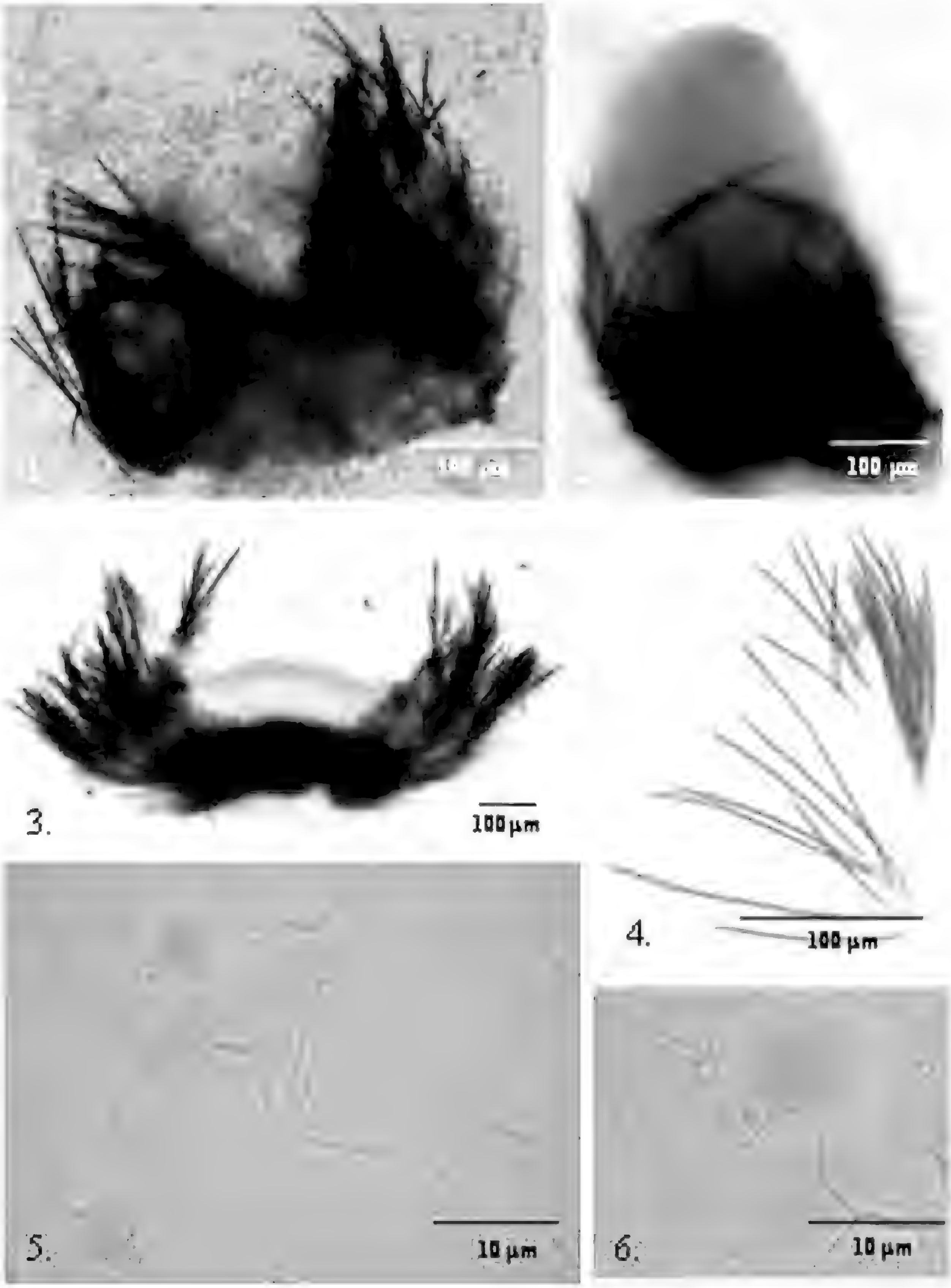
HOLOTYPE: On cattle dung, Yana, Karnataka, India, coll. Ashish Prabhugaonkar, 28.07.08. Herb. No. HCIO 48658

ETYMOLOGY: *yanense* = referring to the collection site.

Colonies slow growing on malt extract agar, slimy, pale orange, circular, 3.5 mm diam. after 20 days of incubation in diurnal light at 22–24°C. Conidiomata cupulate, initially closed, eventually opening, sessile, superficial, scattered, solitary, rarely in aggregates of 2–3, 250–450 µm diam., 500–750 µm high, greenish brown; basal tissue pseudoparenchymatous; conidiomal wall with discernible, straight or curved, thick-walled, smooth, septate, rarely branched, up to 220 µm long and up to 7 µm wide setae. Conidiophores developing in a hymenium, hyaline, smooth, septate, branched once or twice below mid point, 6–23 × 2–3.5 µm. Conidiogenous cells 6.5–20 × 1–5 µm, holoblastic, cylindrical, narrower at the tip, smooth, integrated, determinate, Conidia 6.5–10 × 1.5–2.5 µm, subcylindrical, hyaline, aseptate, solitary, numerous, pale orange in mass, thin-walled, smooth, with one appendage at apex and three at the base, developing through one of the basal appendages; appendages acellular, hyaline, unbranched, cylindrical, smooth, 10–16 µm long, up to 1 µm wide.

Discussion

The genus *Dimastigosporium* Faurel & Schotter, typified by *D. musimonum* Faurel & Schotter (Faurel & Schotter 1965, Nag Raj 1993), is characterized by superficial, cupulate conidiomata, smooth, branched, conidiophores, integrated, hyaline, cylindrical conidiogenous cells and appendaged conidia. Conidia in *D. musimonum* are hyaline, pyriform, 10–16 × 2.5–3 µm, with the primary appendage 16–23 µm long and 2–3 secondary appendages 12–21 µm long. *D. yanense* differs from the type species by smaller, subcylindrical, conidia (6.5–10 × 1.5–2.5 µm) with three basal and one apical appendage of 10–16 µm long. The two species are compared in TABLE 1.



FIGURES 1–6 *Dimastigosporium yanense.* 1–2. Conidiomata; 3. Section through a conidioma; 4. Setiferous hyphae; 5. Conidiogenous cells; 6. Conidia

Sutton (1980: 470), in describing the genus *Dimastigosporium,* wrote: "… during conidiogenesis the body of the conidium is formed first and is attached to the conidiogenous cell by one of the appendages." Nag Raj (1993), in examining

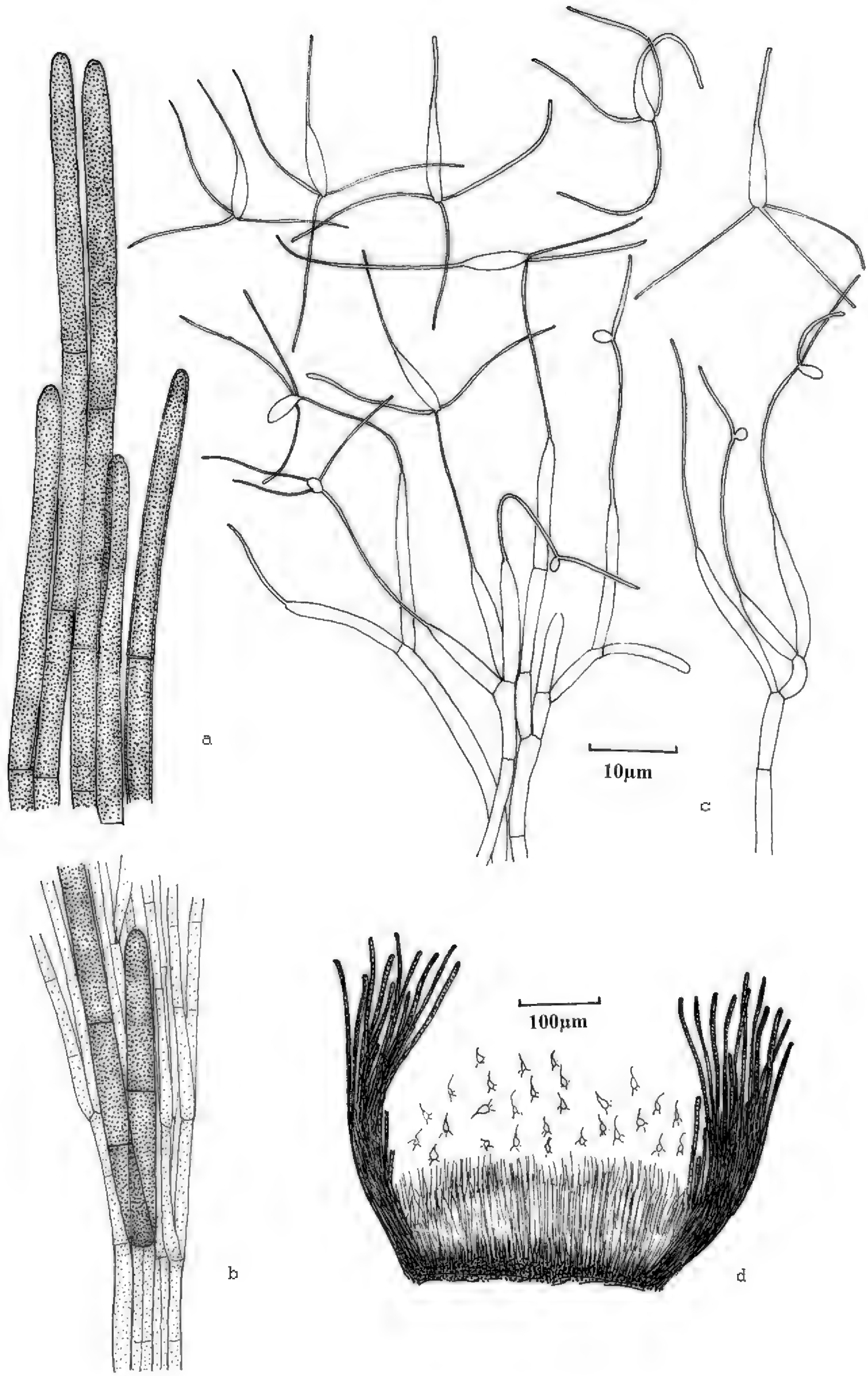

a
10µm
c
100µm
b
d

TABLE 1: Comparison of *D. musimonum* with *D. yanense*

CHARACTERS	*D. musimonum*	*D. yanense*
HABIT & HABITAT	Wild sheep (*Ammotragus lervia*) dung	Cow (*Bos taurus*) dung
CONIDIOMATA	Superficial, cupulate, black or blackish green, 350 µm diam., ≤ 200 µm high	Superficial, cupulate, greenish brown, 250–450 µm diam., 500–750 µm high
CONIDIOMAL WALL TYPE	Pseudoparenchymatous	Textura porrecta
CONIDIOPHORES	Cylindrical, septate, sparingly branched at the base, smooth, hyaline.	Septate, branched below mid point, hyaline, smooth, 6–23 × 2–3.5 µm
CONIDIOGENOUS CELLS	Holoblastic, integrated, subcylindrical to obclavate, hyaline, 11–15 × 1.5–2 µm	Holoblastic, integrated, cylindrical, narrower at the tip, hyaline, 6.5–20 × 1–5 µm
CONIDIA	Pyriform, unicellular, hyaline, thin-walled, smooth, 10–16 × 2.5–3 µm	Subcylindrical, unicellular, hyaline, smooth, rounded at the base, 6.5–10 × 1.5–2.5 µm
CONIDIAL APPENDAGES	Primary appendage 16–23 µm long, 2–3 secondary appendages 12–21 µm	Four; one at the tip, 3 at the base, 10–16 µm long, ≤ 1 µm wide.

the only slide available in the voucher material of *D. musimonum,* could not diagnose the exact nature of conidiogenesis, although he suspected it to belong to the phialidic category. Careful examination of the conidiogenesis in *D. yanense* revealed that conidium ontogeny is holoblastic and the body of the conidium is developed through one of the basal appendages (FIG. 7c).

Coelomycetous genera such as *Eleutheromyces* Fuckel, *Monodia* Breton & Faurel and *Strasseria* Bres. & Sacc. (Nag Raj 1993, Sutton 1980) also exhibit similar conidial development wherein conidiogenesis is initiated through an appendage within a compact ostiolate pycnidium. The conidia develop at the tip of filiform appendages emerging from the conidiogenous cells. In *Eleutheromyces* and *Strasseria*, typified by *E. subulatus* (Fuckel 1870) and *S. carpophila* (Strasser 1902), respectively, the conidia are enteroblastic and phialidic whereas in *Monodia* they are holoblastic. With holoblastic conidiogenesis, appendaged conidia and coprophilous habitat, *Dimastigosporium* is more similar to *Monodia*, typified by *M. elegans* (Breton & Faurel 1970), though the former

FIGURE 7. *Dimastigosporium yanense.* a–b, Setiferous hyphae; c, Conidiogenous cells & Conidia; d, Section of a conidioma.

Table 2. Comparison of *Eleutheromyces*, *Dimastigosporium*, *Monodia* and *Strasseria*

Characters	*Eleutheromyces*	*Dimastigosporium*	*Monodia*	*Strasseria*
Habit and habitat	On *Polyporus picipes* and hymenomycetes	Cow (*Bos taurus*) dung	Herbivorous animal dung	On trees (*Picea excelsa*, *Pinus strobus*, *P. nigra*)
Conidiomata	Pycnidial, gregarious, unilocular, ostiolate, pale brown, 130–350 µm diam. ≤ 3300 µm high	Superficial, cupulate, black or blackish green, 350 µm diam., ≤ 200 µm high	Pyriform, (semi)immersed, ostiolate, dark brown, 240–350 µm diam.	Pyriform, immersed, ostiolate, black to dark brown, 100–350 µm diam.
Conidiomata wall type	Textura angularis	Pseudoparenchymatous	Textura angularis	Textura angularis
Conidiophores	Cylindrical, septate, branched at base, hyaline, smooth, 60 × 2.5–3.5 µm	Cylindrical, septate, sparingly branched at the base, hyaline, smooth, size unknown	Septate, branched, hyaline, smooth, 70 µm long	Cylindrical to lageniform, septate, branched, hyaline, 6–14 × 2–2.5 µm
Conidiogenous cells	Enteroblastic, phialidic, integrated, determinate	Holoblastic, integrated, subcylindrical to obclavate, hyaline, 11–15 × 1.5–2 µm	Holoblastic, integrated, terminal, 8–18 × 1–3 µm	Enteroblastic, phialidic
Conidia	Lenticulate, unicellular, hyaline, 4–5.5 × 1.5–2 µm	Pyriform, unicellular, hyaline, thin-walled, smooth, 10–16 × 2.5–3 µm	Subcylindrical, unicellular, smooth-walled, base truncated 16–24 × 5.5–7 µm	Botuliform, unicellular, hyaline, smooth, 8–15 × 2–3 µm
Conidial appendages	Unbranched, cellular, smooth, thin-walled, eguttulate, 2–7 µm long	Primary appendage 16–23 µm long, 2–3 secondary appendages 12–21 µm	Four filiform, two at either end, unequal in length, 16–23 µm long	One filiform, flexuous, smooth, unbranched, 12–15 µm long

is distinct by absence of discernible pycnidium. In *Dimastigosporium* species, the fructification is a closed structure to begin with; it later attains an open, cupulate shape. The salient features of these genera are summarized in TABLE 2.

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Two new blue species of *Entoloma* (*Basidiomycetes, Agaricales*) from South China

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Abstract — Two new species of *Entoloma* are described. *E. subaltissimum* is characterized by its blue pileus, distant to subdistant lamellae, quadrate basidiospores and broadly clavate cheilocystidia; and *E. dinghuense* by the blue pileus, 5–6-angled basidiospores and subvesicular or subclavate pleurocystidia.

Key words — *Entolomataceae*, taxonomy

Introduction

At least 132 species of *Entolomataceae* have been recorded in China (Li et al. 2008), with over 600 *Entoloma* collections being deposited in various herbaria. About one third of these originate from South China, an area of tropical and subtropical climate; another third from Southwest China with tropical monsoon climate and various mountain plateau climates; and the remaining from various low temperature climatic zones elsewhere in China. When studying the specimens for compiling a Flora Fungorum Sinicorum on *Entolomataceae*, 24 collections from South China characterised by a blue pileus were re-examined by the authors. Two collections were found possessing characters distinct from those found in any previously described taxa and are herein formally recognized. The holotypes are deposited in the Herbarium of Guangdong Institute of Microbiology (GDGM).

*Corresponding author

Materials and methods

Specimens were annotated in the field, and dried in an electric drier, then deposited in the herbarium. Tissues were mounted in 5% potassium hydroxide solution (KOH) and 10% ammonia (NH_4OH) for microscopic examination. Dimensions of basidiospores (excluding the apiculus), basidia (excluding the sterigmata), cystidia (if present) and hyphal diameter are given with *(a–)b–c (–d)*. The range *b–c* contains the mean value of 20–30 objects measured. Extreme values *a* and *d* are given in parentheses, where appropriate. Photographs of microscopic characters were taken with a trinocular phase contrast microscope with light optics (Nikon Eclipse 80i), and an image was taken under a scanning electron microscope (Philips FEI-XL30). Colour designations within parentheses followed Kornerup & Wanscher (1978).

Taxonomy

Entoloma subaltissimum T.H. Li & Chuan H. Li, **sp. nov.** FIGS. 1–6

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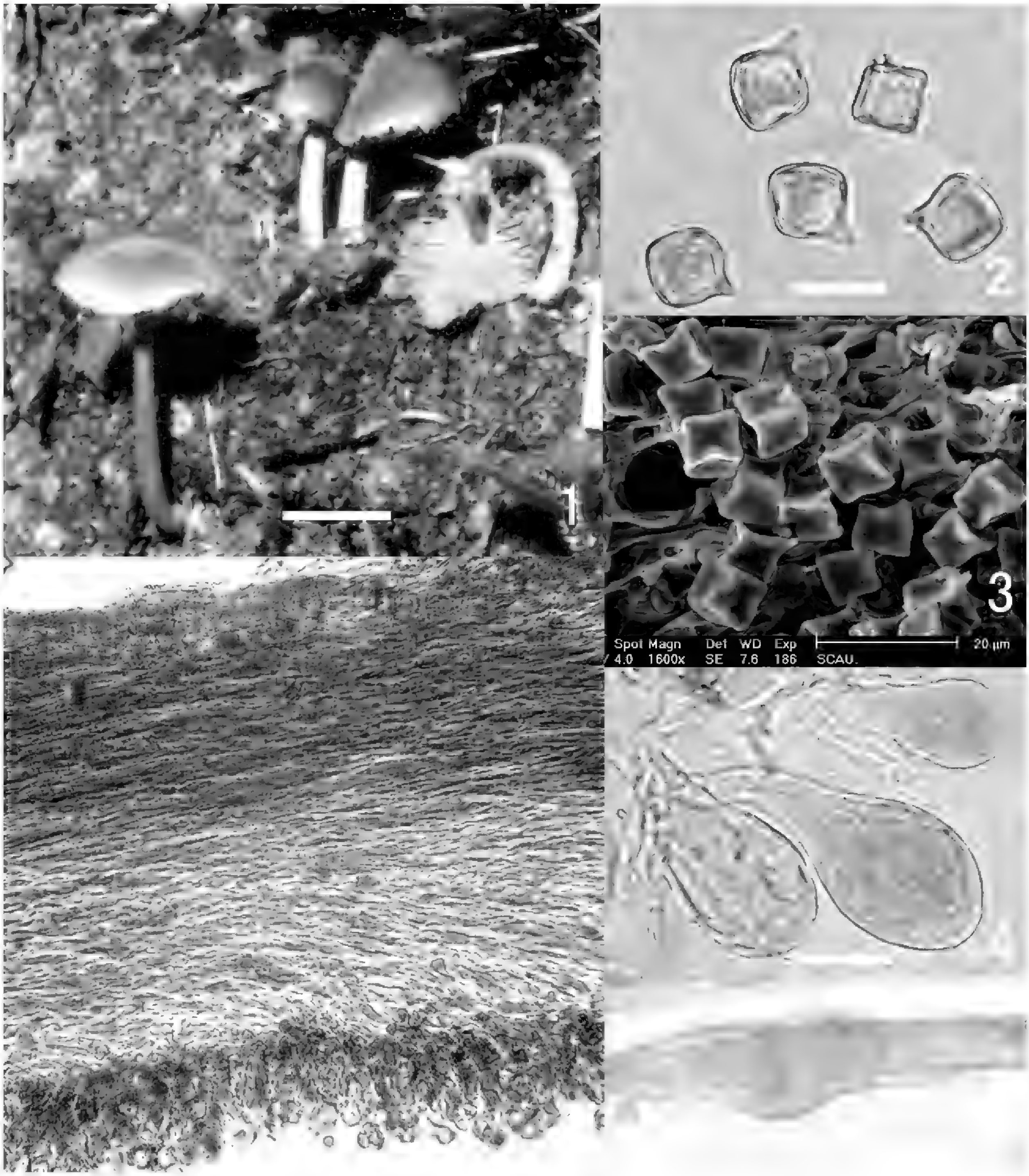
PILEUS 20–35 mm latus, conicus, hemisphericus vel convexus, lazulinus, maculis fulvis quum tactu, furfuraceus, leviter striatus. LAMELLAE fere liberae vel adnexae, dilute lazulinae, 2–3.5 mm latae, distantes vel subdistantes. STIPES 50–80 × 2–3 mm, cylindraceus, concolor cum pileo. BASIDIOSPORAE 8.5–12.5 × 8–12 µm, subquadratae vel quadratae. BASIDIA 27–50 × 10–15 µm, clavata, 2–4-sporigera, fibulata. CHEILOCYSTIDIA 50–76 × 15–29 µm, clavata. PLEUROCYSTIDIA desunt. PILEIPELLIS ex hyphis 4–15.5 µm crassis, repentibusis. PILEIPELLIS et STIPITIPELLIS hyphis fibulatis. PILEOCYSTIDIA et CAULOCYSTIDIA desunt.

HOLOTYPE: China, Hainan Province, Ledong County, Jianfengling National Nature Reserve, alt. 900 m, 28 December 1987, T.H. Li GDGM **holotype** 12490.

ETYMOLOGY: named based on morphological similarities shared with a previously named species, *Entoloma altissimum*.

BASIDIOMATA small-sized, mycenoid, mostly blue with some rusty yellow (2A3–3A3) maculae on pileus, stipe and lamellae where bruised or drying. PILEUS 20–35 mm broad, conical to hemispherical, papillate or not when young, becoming convex with age, denticulate or crenate at margin, glabrous to weakly furfuraceous, hygrophanous, slightly striate, deep blue (22A4–23A4), pale turquoise or light green (24A3–25A4), turquoise grey to greenish green (24B2–25B2), sometimes pale blue (22A3–23A3) near margin. LAMELLAE 2–3.5 mm broad, subfree to adnexed, distant to subdistant, ventricose, light blue (22A5–23A5), tinted with pink, lamellulae present; lamellar edge entire. STIPE central, 50–80 mm long, 2–3 mm thick at apex, cylindrical, slightly enlarged downwards, concolorous with pileus or paler, usually pale blue (22A3–23A3) to light blue (22A5–23A5) at apex and near base, glabrous, hollow. CONTEXT thin, light blue (22A5–23A5) to pale green (25A3). TASTE peppery.



FIGS. 1–6: *Entoloma subaltissimum* (GDGM 12490).
1. Basidiomata. 2. Basidiospores. 3. Basidiospores under SEM (untreated with OsO_4).
4. Cheilocystidia. 5. Clamp connection in pileipellis. 6. Radial section of pileus.
Bars: 1= 2 cm; 2, 5= 10 µm; 3, 4 and 6= 20 µm

BASIDIOSPORES 8.0–12.5 × 8–12 µm, subquadrate to quadrate, cuboid under scanning electron microscope, with obvious apiculus, smooth, pinkish. BASIDIA 27–50 × 10–15 µm, clavate, 2–4-spored, with sterigmata 2.5–5 µm long, clamped at base, with yellow-brown pigment in KOH. CHEILOCYSTIDIA 50–76 × 15–29 µm, broadly clavate, with yellow-brown vacuolar pigment in KOH. PLEUROCYSTIDIA absent. LAMELLAR TRAMA HYPHAE subparallel,

10–34 µm broad, cylindrical to inflated, thin-walled, hyaline. PILEIPELLIS a cutis composed of repent hyphae 4–15.5 µm broad, with blue intracellular pigment in suprapellis and brown cytoplasmic pigment in hypodermal hyphae in NH_4OH or KOH. STIPITIPELLIS a cutis composed of subparallel hyphae, with blue intracellular pigment in suprapellis in NH_4OH. PILEOCYSTIDIA and CAULOCYSTIDIA absent. CLAMP CONNECTIONS present in all tissues.

HABIT, HABITAT and DISTRIBUTION: Scattered on soil in a broadleaf forest; known only from the type locality.

COMMENTARY: *E. subaltissimum* is a member of section *Staurospora* (Noordeloos 1981, Singer 1986). The new species is characterized by its blue basidiomata, usually with rusty yellow maculae on pileus, stipe and lamellae where bruised or drying, peppery taste, quadrate basidiospores, and broadly clavate cheilocystidia with yellow-brown vacuolar pigment.

At least 107 species of *Entoloma* with a blue pileus have been formally described, but blue-capped species in section *Staurospora* is until now rare. Two Asian species, *E. altissimum* (Massee) E. Horak originally described from Singapore and *E. virescens* (Berk. & M.A. Curtis) E. Horak ex Courtec. from Bonin Islands of Japan, and an Oceanian species, *E. hochstetteri* (Reichardt) G. Stev. from New Zealand, are similar to the new species in those aspects. Nevertheless, these species have their own distinctive characters: *E. altissimum* has a non-striate, fibrillose pileus, crowded lamellae, smaller basidiospores (7–10.5 µm), and longer but narrower, cylindrical to clavate cheilocystidia with brown plasmatic pigment (50–130 × 6–20 µm) (Horak 1975); *E. virescens* has closer lamellae, fusoid to cylindrical pseudocystidia and lactiferae, and lacks cheilocystidia (Courtecuisse 1986); and *E. hochstetteri* has larger basidiospores (11–15 × 11–14 µm), fusoid and thinner cheilocystidia (40–60 × 8–14 µm) (Stevenson 1962, Horak 1973). *E. azureoviride* E. Horak & Singer from Brazil, South America also has a blue pileus and cuboid basidiospores, but it has close to crowded lamellae and smaller basidiospores (5–8.5 µm) (Horak 1982). Microscopically, there are also many species of *Entoloma* with quadrate or cuboid basidiospores, especially in southeastern and southern Asia (Horak 1975, 1980; Manimohan 1995, 2006), but those, apart from the species mentioned above, do not have a blue pileus.

Macroscopically, the following additional species could be confused with *E. subaltissimum* for their similar blue colour and size of basidiomata, but they can easily be distinguished in microscopic characters: both *E. rugosopruinatum* (reported from Sabah, Malaysia) and *E. strictum* (from New Zealand) have 5–6-angled basidiospores and lack cystidia (Stevenson 1962; Horak 1973, 1980); *E. nitidum* from Europe has 6–8-angled basidiospores and lacks cystidia (Noordeloos 1981, 1987); *E. euchroum* from Europe has 5–7-angled

basidiospores and smaller cheilocystidia (22–50 × 5–15 µm) (Noordeloos 1987); and *Leptonia decolorans* f. *atropruinosipes* from North America has 5–6-angled basidiospores and narrower cheilocystidia (33.1–84.7 × 5.4–9.4 µm) (Largent 1994).

Entoloma dinghuense T.H. Li & Chuan H. Li, **sp. nov.** FIGS. 7–11

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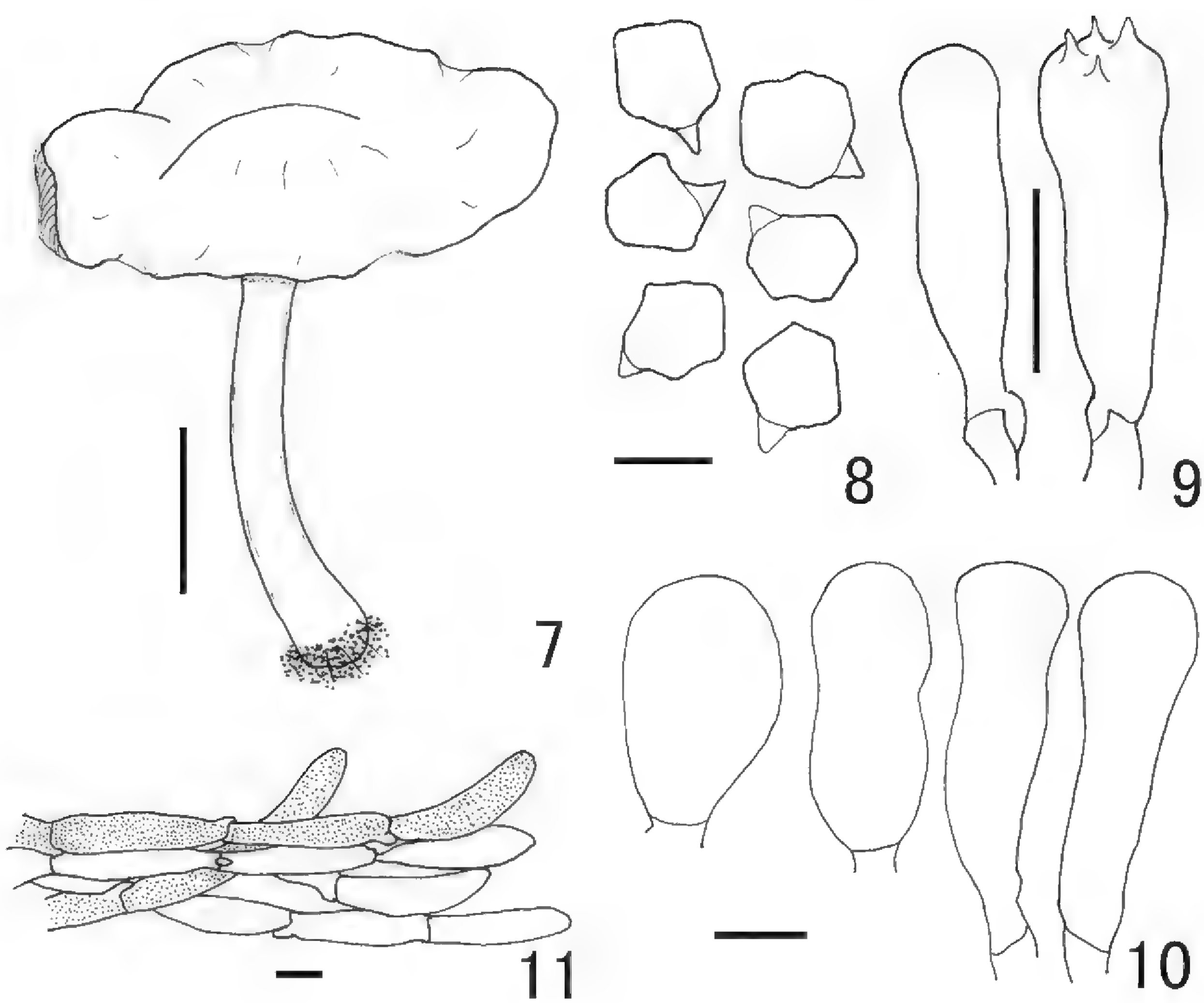
PILEUS 70 mm latus, convexus vel planus, estriatus, lazulinus. LAMELLAE adnexae, distantes vel subdistantes. STIPES 60 × 6 mm, cylindraceus. BASIDIOSPORAE 8–11.5 × (6–)7.5–8.5(–10) µm, 5–6-angulatae. BASIDIA 38.5–41 × 9.5–14.5 µm, clavata, 2–4(–6)-sporigera, fibulata. PLEUROCYSTIDIA 45–69 × 24–33.5 µm, subglobosa vel cylindraceo-clavata. PILEIPELLIS ex hyphis 4–10.5(–15.5) µm crassis, repentis. PILEIPELLIS et STIPITIPELLIS hyphis fibulatis. PILEOCYSTIDIA et CAULOCYSTIDIA desunt.

HOLOTYPE: China, Guangdong Province, Dinghushan Biosphere Reserve, alt. 100 m, 24 May 1987, Z.S. Bi & T.H. Li GDGM **holotype** 11782.

ETYMOLOGY: named in honor of the type locality, Dinghushan Biosphere Reserve.

BASIDIOMATA medium-sized, collybioid. PILEUS 70 mm broad, convex to plane with broad umbo, smooth, not viscid, estriate, slightly uplifted at margin with age, light blue to pale blue (22A5–23A3), greenish blue (28E2–30E2) when dry. LAMELLAE 5–7 mm broad, adnexed, distant to subdistant, lamellulae present, white when young, pinkish to pink with age; margin entire. STIPE 60 mm long, 6 mm thick at apex, central, cylindrical, slightly enlarged towards base, concolorous with pileus or paler, pale blue (22A3–23A3) at apex, becoming deeper blue downwards, light blue to pale blue (22A5–23A3) near base, glabrous, solid. PILEAL CONTEXT 3 mm thick at stipe, thin, white. TASTE and SMELL mild.

BASIDIOSPORES 8–11.5 × (6–)7.5–8.5(–10) µm, isodiametric to subisodiametric, 5–6-angled in side-view, with obvious apiculus, pinkish. BASIDIA 38.5–41 × 9.5–14.5 µm, clavate, sometimes with many oil droplets, 2–4(–6)-spored, mostly 4-spored, but occasionally 6-spored, with sterigmata 1.5–5 µm long, clamped, hyaline in KOH. PLEUROCYSTIDIA 45–69 × 24–33.5 µm, subvesicular, cylindrical-clavate to broadly clavate, sometimes with blunt tip, brownish in KOH. CHEILOCYSTIDIA absent. LAMELLAR TRAMA HYPHAE subparallel, 5–19.5 µm broad, cylindrical to inflated, thin-walled, colourless and hyaline. PILEIPELLIS a cutis composed of repent hyphae 4.5–10.5(–15.5) µm broad, with slightly ascending terminal elements, thin-walled, with greenish blue intracellular pigment in suprapellis in NH_4OH, brownish cytoplasmic pigment in hypodermic hyphae in NH_4OH or KOH. STIPITIPELLIS HYPHAE subparallel, 3.5–17 µm broad, with greenish blue-brown intracellular pigment in suprapellis in NH_4OH. PILEOCYSTIDIA and CAULOCYSTIDIA absent. CLAMP CONNECTIONS present in all tissues.



Figs. 7–11: *Entoloma dinghuense* (GDGM 11782).
7. Basidioma. 8. Basidiospores. 9. Basidia. 10. Pleurocystidia. 11. Pileipellis.
Bars: 7= 2 cm; 8 and 11= 10 µm; 9 and 10= 20 µm

Habit, habitat and distribution: Solitary on soil in a mixed forest; known only from the type locality.

Commentary: *E. dinghuense* is characterized by its combination of medium-sized collybioid basidiomata, a blue pileus, adnexed and distant to subdistant lamellae, isodiametric to subisodiametric basidiospores, clamped basidia and subvesicular, cylindrical-clavate to broadly clavate pleurocystidia. It should be placed in section *Rhodopolia* of subgenus *Entoloma* (Noordeloos 1981), but no blue-capped species under section *Rhodopolia* has been reported until now. In subgenus *Entoloma*, the new species may be confused with *E. coeruleomagnum* G.M. Gates & Noordel. originally reported from Tasmania, Australia in the blue pileus and 5–6-angled basidiospores. However, *E. coeruleomagnum* has a tricholomatoid basidioma, a large pileus, caulocystidia, a palisadoderm of erect hyphae in the pileipellis, and lacks hymenophoral cystidia (Gates & Noordeloos 2007).

Three other species with a medium-sized blue pileus and 5–6-angled basidiospores should also be compared with the new species. Two of them, *Rhodophyllus callidermus* Romagn. (from Congo) and *E. griseolazulinum* Manim. & Noordel. (from India) belong to section *Calliderma* of subgenus *Inocephalus*. *R. callidermus* lacks hymenophoral cystidia and clamp connections (Romagnesi 1957); *E. griseolazulinum* has a greyish blue pileus, free, crowded lamellae, and heterodiametrical basidiospores (Manimohan 2006). A third species, *E. viiduense* Noordel. & Liiv from Estonia, which belongs to section *Cyanula* of subgenus *Leptonia*, has a depressed to umbilicate pileus, 5–7(–8)-angled basidiospores and lacks hymenophoral cystidia (Noordeloos 1992).

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MYCOTAXON

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Sarcogyne magnispora (*Acarosporaceae*), a new species in the *nivea* group from Turkey

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Abstract — A new species of *Sarcogyne* in the calcareous *nivea* group is described from the uplands of central Anatolia, Turkey. It is distinguished from other species in the group by its larger ascospores.

Key words — *Ascomycota*, lichens, taxonomy

Introduction

Sarcogyne Flot. (*Acarosporaceae*) is a genus of lichens distinguished by polyspory, hyaline simple ascospores, and a non-amyloid tholus, occurring on acidic or calcareous rocks that is currently separated from *Acarospora* by the lack of a thalline margin. The type species of the genus *Sarcogyne* is *S. corrugata* Flot., a synonym of *S. clavus* (DC.) Kremp. (Jørgensen & Santesson 1993). The core group of species, *Sarcogyne* sensu stricto, includes such species as *S. algoviae* H. Magn., *S. privigna* (Ach.) A. Massal., *S. reebiae* K. Knudsen, and *S. lapponica* (Ach. ex Schaer.) K. Knudsen & Kocourk., which all have a carbonized proper exciple in which the excessive build-up of pigmentation obscures the hyphae of the margin. *Sarcogyne* sensu stricto, however, lacks the buildup of carbonized accretions on the epihymenial surface that occurs in the species that Vězda (1978) grouped in *Polysporina*. The genus is badly in need of a revision using molecular data to evaluate morphological data and to form natural genera. For

TABLE 1. Comparison of the members of the *nivea* group.

SPECIES	THALLUS	APOTHECIA (mm diam.)	HYMENIUM (µm)	ASCOSPORE SIZE (µm)
S. algerica	Present	0.7–1.5	85–100	5–7 × 3–3.5
S. cretacea	Present	0.5–0.8	100–120	4–5.5 × 2–3
S. distinguenda	Present	0.6–2.0	110–180	3–4.5 × 3–3.5
S. fallax	Absent	0.7–1.0	110–150	3–5.5 × 3–4
S. magnispora	Present	1.0–2.0	140–200	10–11 × 6–7
S. nivea	Present	0.3–0.6	80–100	(3.5–)4–5.5 × 3–3.5
S. polackiana	Present	0.4–0.5	65–80	5–7(–8) × 3–3.5

example, Reeb (Reeb et al. 2004) found that *Sarcogyne regularis* Körb. was closely related with *Acarospora glaucocarpa* (Ach.) Körb., which raises the question whether at least part of *Sarcogyne* should be included in a new segregate genus containing related species both with and without a thalline margin.

The *Sarcogyne nivea* group is morphologically similar to the *S. regularis* group in having a non-carbonized exciple, hyaline hypothecium, and in occurring on calcareous substrates (Magnusson 1935, 1937, Clauzade & Roux 1985, Knudsen & Standley 2008). The *nivea* group, which is artificially differentiated from the *regularis* group strictly for purposes of specimen identification, is distinguished by having broadly ellipsoid to globose ascospores while the *regularis* group has ellipsoid ascospores. Members of the *nivea* group as treated here include *S. algerica* H. Magn., *S. cretacea* Poelt, *S. distinguenda* Th. Fr., *S. fallax* H. Magn., *S. nivea* Kremp., and *S. polackiana* (Müll. Arg.) H. Magn. All of these species have an epilithic thallus except for *S. fallax*. But, *S. arenosa* (Herre) K. Knudsen & Standley and *S. latericola* J. Steiner of the *regularis* group have epilithic thalli too. The table of main characters in the *nivea* group (TABLE 1) suggests the possibility that some species are synonyms. Thickness of thallus, paraphyses width, and the number of ascospores per ascus are not included in the table, but with further study may help to morphologically better distinguish species. For instance *S. cretacea* has a thallus of 5 mm thick, while the thalli of other species are thin or lacking in *S. fallax* and that is obviously an important primary character.

Material and methods

The type of the new species is deposited in the lichen herbarium of Erciyes University, Biology Department (Kayseri, Turkey). Hand sections were studied in water, potassium hydroxide (KOH), Lugol's (IKI) and lactophenol cotton blue. Measurements were made in water. Ascospore measurements are given as (X – SD) –X– (X + SD) with X ± SD.

The species

Sarcogyne magnispora K. Knudsen & Halıcı, **sp. nov.**

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Similis Sarcogyne niveo *agg., sed differt ascosporis majoribus (8.8)–10–(11.2) × (5.2)–6.1–(6.9) µm.*

Type specimens: Turkey, Sivas, Gürün District, Gökpınar, 38°39.251'N, 37°18.108'E, alt. 1550 m, on exposed calcareous rocks, 09 August 2008, leg. M. Kocakaya (MGH 0.5493 – **holotype**; UCR– **isotype**).

Etymology: The epithet "*magnispora*" refers to the large ascospores.

Description: Thallus white, epilithic, ecorticate and poorly stratified, to over 2 cm in width with abundant superficial apothecia, mostly 200–300 µm thick, hyphae obscure in water, 2 µm thick, becoming gelatinized, and intermixed with abundant crystals positive in polarized light and not dissolving in KOH. Algal layer discontinuous, photobiont chlorococcoid green alga, cells mostly 5–10 µm in diameter. Apothecia superficial, black, with distinct proper margin becoming almost excluded, convex to very convex, rarely dividing, 1–2 mm in diameter, sometimes forming a short stipe. Disc black, epruinose, not changing color when wetted. Exciple reddish-brown, 50–90 µm thick, composed of radiating hyphae, inspersed with crystals. Epihymenium reddish-red, 8–10 µm thick, conglutinated. Hymenium 120–200 µm high, orange in thick section, hyaline to slightly yellowish in thin section, conglutinate in water, but spreading easily in squash, paraphyses 2–3 µm wide, septate, not branching, apices slightly expanded in thick dark reddish gel. Asci clavate, 80–100 × 20–35 µm, mostly 50 ascospores per asci. Ascospores (8.8)–10–(11.2) × (5.2)–6.1–(6.9) µm ($n = 20$). Subhymenium about 10 µm thick, obscure. Hypothecium ochraceous, appearing dark under the microscope but not carbonized, actually hyaline but obscured by abundant crystals, hyphae continuous with exciple and thallus, mostly thin-walled, 2 µm thick. Conidiomata not observed.

Ecology, Substrate and distribution: On exposed calcareous rock at an elevation of 1562 meters. Gürün District, where the holotype was collected, belongs to Sivas Province and, is situated in the Irano-Turanian phytogeographical region. In the area, marly hills are pre-dominant. So far known only from type locality in the uplands of Central Anatolia, Turkey.

Discussion: *Sarcogyne magnispora* is obviously a member of the *nivea* group as understood in this paper. It has an uncarbonized exciple, a hyaline hypothecium, occurs on a calcareous substrate, and has broadly ellipsoid ascospores. It has a thin thallus like most species in the *nivea* group, except *S. cretacea*, which has a thallus 5 mm thick and *S. fallax*, which lacks a thallus. The apothecia of *S. magnispora* are the largest in the group and are 2 mm in diameter when fully developed. The other members of the group have apothecia

1 mm or less in diameter except for *S. algerica*, which has apothecia up to 1.5 mm in diameter. The hymenium of *S. magnispora* is from 120 µm to as tall as 200 µm, and overlaps with ranges of *S. distinguenda* and *S. fallax* both which have smaller ascospores than *S. magnispora* [3–4.5 × 3–3.5 µm and 3–5.5 × 3–4 µm respectively vs. (8.8)–10–(11.2) × (5.2)–6.1–(6.9) µm]. As can be seen in Table 1, *S. magnispora* has the largest ascospores in the whole group.

The only species described in the genus with similarly large ascospores is *Sarcogyne oligospora* H. Magn. with ascospores 7–10 × 4–5 µm according to Magnusson (1952). This species has carbonized accretions of the epihymenium and thus following current generic concepts was transferred to *Polysporina* (Knudsen & Lendemer 2005). In the revision of *P. oligospora* (H. Magn.) K. Knudsen by K. Knudsen & J. Kocourková (in prep.), using ample isotype and topotype material from COLO, it was found that mature ascospores were actually much smaller (mostly 3.8–6.0 × 2.0–3.0 µm) than described by Magnusson. Otherwise, *P. oligospora* differs from *S. magnispora* primarily in having a carbonized exciple as well as carbonized accretions on the epihymenium and in lacking an epilithic thallus.

We expect the species to be more widespread in Turkey although its global distribution is an open question. As with all species described from a single specimen, we expect the variation to be better understood in the species as new collections are accumulated.

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Amanita coacta (*Amanitaceae, Agaricales*) with a key to *Amanita* species occurring in Brazil

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Abstract — *Amanita coacta* was described from Amazonas State, Northern Brazil, in 1978 based on a single collection, and since then no more records have been reported. Sixteen collections of this species were made from Parque Estadual das Fontes do Ipiranga, São Paulo State, Southeast Brazil. These collections form a basis for a re-description including range variation of spore size and shape. An artificial dichotomous key to all *Amanita* species occurring in Brazil is also presented.

Key words — *Basidiomycota*, Atlantic forest, taxonomy

Introduction

Amanita Pers. is a well-known genus of *Basidiomycota* with global distribution. It has morphological, anatomical, and developmental characteristics useful for its macroscopical recognition and support inside the family *Amanitaceae* R. Heim ex Pouzar (Drehmel et al. 1999, Oda et al. 1999, Zhang et al. 2004). The genus is characterized by the mycorrhizal habit, hemiangiocarpic development, lamellae that are usually white and free, pallid basidiospores, bilateral hymenophoral trama, and longitudinally acrophysalidic stipe tissue (Bas 1969).

The genus comprises ca. 500 species (Kirk et al. 2001) with 19 taxa mentioned for Brazil, including *A. muscaria* (L.) Lam. (Homrich 1965, Figueiredo et al. 1996, Fosco-Mucci & Yokomizo 1985, Giachini et al. 2000, 2004, Meijer 2001, 2006, Sobestiansky, 2005), *A. pantherina* var. *multisquamosa* (Peck) Jenkins (Giachini et al. 2000, 2004) and *A. rubescens* Pers. (Sobestiansky 2005), all of which were frequently collected in reforestation area with plantations of exotic trees and so likely introduced with seedlings.

Rick (1906) was the first author to describe species of *Amanita* from Brazil. Since then, other publications (Rick 1930, 1937, 1961, Singer 1953, Bas 1978, Grandi et al. 1984, Capelari & Maziero 1988, Bas & Meijer 1993, Pegler 1997, Wartchow et al. 2007, Wartchow & Maia 2007) have contributed to our knowledge of the genus in Brazil.

The study by Bas (1978), although restricted to species collected by Rolf Singer in Amazonas State in Northern Brazil, undoubtedly provides the best knowledge about *Amanita* in Brazil. In his work, eight species with Brazilian types were described, including *A. coacta,* based on a single collection from Amazon Forest.

In this article, *A. coacta* is reported for the first time outside the Amazon region, in a remnant of Atlantic forest of Southeast Brazil. This record represents the second collection of this species since its description. We provide an updated description of the species and present for the first time photos of *A. coacta* showing different morphological patterns. An artificial dichotomous key for *Amanita* species in Brazil is also presented.

Material and methods

The specimens studied were collected at the Parque Estadual das Fontes do Ipiranga, a Atlantic forest remnant in São Paulo State, Southeast Brazil, and deposited at herbarium SP. Fresh specimens were photographed and macro-morphological data were recorded. Color terms are according to Küppers (1979).

For microscopic analyses, the dried material was rehydrated in 70% ethanol followed by 5% KOH or Melzer's reagent. All microscopic illustrations were made with the aid of a drawing tube. The spores were measured in lateral view. The method for metric values follows Tulloss (1993). At the beginning of a set of spores data, the notation "[*a*/*b*/*c*]", where *a*, *b*, and *c*, are integers, is to be read "*a* spores were measured from *b* basidiomata taken from *c* collections". When ranges are provided in spore data in the form "(*m*–)*n*–*o* (–*p*)", where *m*, *n*, *o* and *p* are integers, the values given are to be understood as follows: *m* is the lowest values observed or calculated and *p* the highest. In the range of values observed or calculated, the 5th percentile is *n* and the 95th percentile is *o.* A summary of definitions of biometric variables follows:

W_{cs} = breadth of central stratum of lamella.

W_{st}-near = distance from one side of central stratum to nearest base of basidium.

W_{st}-far = distance from one side of central stratum to the most distant base of basidium on the same side of the central stratum.

L, (**W**) = the range of average lengths (widths) of spores of each basidioma examined.

L', (**W'**) = the average of all lengths (widths) of spores measured.

Q = the ratio of length to width of a spore or the range of such ratios for all spores measured.

Q = the average of Q computed for all basidiomata examined.

Q' = the average of all Q values computed for all spores measured.

DNA sequences of the large subunit (LSU) of nuclear ribosomal DNA were obtained from two collections, for future phylogenetic molecular studies. GenBank accession numbers are cited below the species name at the beginning of the formal description. The dichotomous key presented is based on literature. Generic and infrageneric names and concepts follow Corner & Bas (1962) and Bas (1969).

Results

Taxonomy

Amanita coacta Bas FIGS. 1–2

GENBANK FJ236806, FJ236807

MACROCHARACTERS — PILEUS 45–69 mm diam, plane-convex, sometimes slightly depressed at centre or concave, dark grayish brown ($N_{80}A_{30}M_{50}$ to $N_{80}A_{60}M_{60}$) at center, somewhat slightly paler toward the margin, margin rather densely sulcate-striate, dry to subviscid, with gray to brownish gray patches of the universal veil scattered or concentrated at center, occasionally lacking volval remnants on pileus. LAMELLAE free, white, crowded, with or without dark grayish edge; lamellulae scarce or absent, truncate. STIPE 62–100 × 4–8(apex)–8–11(base) mm, subcylindrical, thicker toward the base but without bulb, central, hollow, pale cream with small grayish to grayish-brown fibrils, exannulate. VOLVA at base of stipe, felted-submembranous, with whitish to grayish short fibrils, thin and fragile, easily breakable into grayish patches clearly separated, often forming incomplete transverse zones.

MICROCHARACTERS — BASIDIOSPORES [340/17/16] 8.7–10(–11.2) × (6.2–)7.5–8.7(–10) µm [L = 8.05–10.04; L' = 9.46; W = 6.85–8.4; W' = 7.76; Q = (1.12–)1.15–1.33(–1.4); **Q** = 1.17–1.3; **Q'** = 1.22], subglobose to broadly ellipsoid, rarely ellipsoid, inamyloid, colorless, hyaline, smooth, thin–walled, with large guttule or frequently with precipitated internal content; apiculus lateral to sublateral. BASIDIA (23–)31–46(–56) × (8.7–)10–12.5(–13.7) µm, clavate, thin-walled, frequently with precipitated internal content, 4-spored, with sterigmata up to 6.2 µm. PLEUROCYSTIDIA and CHEILOCYSTIDIA absent. SUBHYMENIUM cellular, up to 25 µm width, as 2–4 layers of more or less isodiametric to irregular cells, (8.7–)10–18.7(–21) × (6.2–)8.7–12(–15) µm; W_{st}-near = 15–31, W_{st}-far = (32–)37–44. LAMELLA TRAMA bilateral, slightly divergent, with W_{cs} = 25–37, composed of thin-walled hyphae, hyaline, septate, sometimes branched and slightly inflated, 3.7–8.7(–15) µm diam., and usually with divergent terminal inflated elements up to 35 µm diam. PILEUS CONTEXT undifferentiated, approximately 162 µm thick, composed of thin-walled hyphae, hyaline, septate, 3.7–8.7(–12.5) µm diam. STIPE CONTEXT longitudinally acrophysalidic, with undifferentiated hyphae 3.7–6.2 µm diam., acrophysalides thin-walled, 162–225 × 27–34 µm, and sometimes with oleiferous hyphae up to 12.2 µm diam. PILEIPELLIS as cutis up to 210 µm thick, composed of thin-walled hyphae, 2.5–10 µm diam., with brown vacuolar pigment and with few conspicuous subradial elements, with or without an ixocutis layer up to 50 µm thick on top, sometimes with distinctive volval remnants. UNIVERSAL VEIL ON PILEUS consisting of undifferentiated hyphae 2.5–6.2 µm diam., thin-walled, slightly yellowish, septate, moderately branched, loosely interwoven, with inflated terminals elements and ovoid, globose or subglobose cells, (25–)

30–60(–69) × (19–)22–51(–65) µm, with light brown vacuolar content, thin-walled. Universal veil on basal part of stipe consisting of undifferentiated hyphae, 2.5–7.5 µm diam., thin-walled, slightly yellowish, septate, moderately branched, loosely interwoven, with inflated terminals elements and ovoid, globose or subglobose cells, (20–)25–38(–50) × (16–)20–34(–44) µm with light brown vacuolar content, thin-walled. Clamps absent in all parts examined.

Habitat and substrate — Solitary or in small groups (two to three basidiomata near) on soil in a remnant of Atlantic forest in São Paulo City.

Specimens examined — **BRAZIL. São Paulo State**: São Paulo, PARQUE ESTADUAL DAS FONTES DO IPIRANGA — 29.I.1960, Fidalgo & Furtado s.n. (SP); 21.I.1987, Pegler 3810 (SP); 20.I.1999, M. Capelari et al. s.n. (SP); 20.II.2002, M. Capelari et al. 4148 (SP); 19.XI.2002, M. Capelari & D.M. Vital 4189 (SP); 02.IV.2003, U.C. Peixoto s.n. (SP); 16.II.2004, M. Capelari et al. 4269 (SP); 15.II.2005, M. Capelari & F.V. Neves 4308, 4309 (SP); 03.III.2005, G.R. Leal s.n. (SP); 07.IV.2005 M. Capelari s.n. (SP); 11.I.2007, F. Karstedt & Menolli Jr. 841 (SP); 14.II.2007, Menolli Jr. et al. 99, 100, 101 (SP); 20.IV.2007, Menolli Jr. et al. 126 (SP).

Comments — *Amanita coacta* is a typical neotropical species of subgenus *Amanita*, section *Vaginatae* (Fr.) Quél. due to its inamyloid basidiospores, a densely sulcate pileus margin, a subcylindrical stipe without a bulbous base, and submembranous-felted volva. However, our southeastern Brazilian collections present some differences when compared to the description in the protologue of the type from Amazonas State, Northern Brazil.

Our collections have subhymenium cells slightly shorter and cells of the universal veil on pileus longer than those described in the protologue [25(–35) mm for subhymenium cells and 20–35 mm for volval remnants cells].

The information provided here improves our knowledge of the micro-characters of *A. coacta* including range in spore size and shape and clarifies some characters, such as the lamella trama, which according to the protologue is “impossible to study in type” (Bas 1978). Other macro-morphological variations were not described in the protologue for *A. coacta* because the type is a single basidioma (collected in 1977 by Singer) that Bas had probably not examined fresh. Therefore, we report new morphological variations such as occurrence in small groups predominantly in summer months, a pileus commonly plane-convex and occasionally without volval remnants, an occasionally dark grayish lamellar edge, a stipe with measurable differences between apex and base, and a volva that often forms incomplete transverse zones.

In one collection of *A. coacta* (M. Capelari et al. 4148), at first sight the stipe surface appears to have concentric annuli one-third upwards from the base (Fig. 1j–l). However, this is a misinterpretation because the “annuli” are actually the result of the stipe surface cleaving, probably due to exposure to the sun in an open field instead of the shaded margin of trails in the forest where all other specimens were collected.

FIGURE 1: *Amanita coacta* collections. a. F. Karstedt & Menolli Jr. 841. b. M. Capelari & D.M. Vital 4189. c. M. Capelari et al. 4269. d. M. Capelari & F.V. Neves 4309. e. Menolli Jr. et al. 99. f–g. Menolli Jr. et al. 126. h. Menolli Jr. et al. 101. i. M. Capelari & F.V. Neves 4308. j–l. M. Capelari et al. 4148. Scale bar = 1 cm.

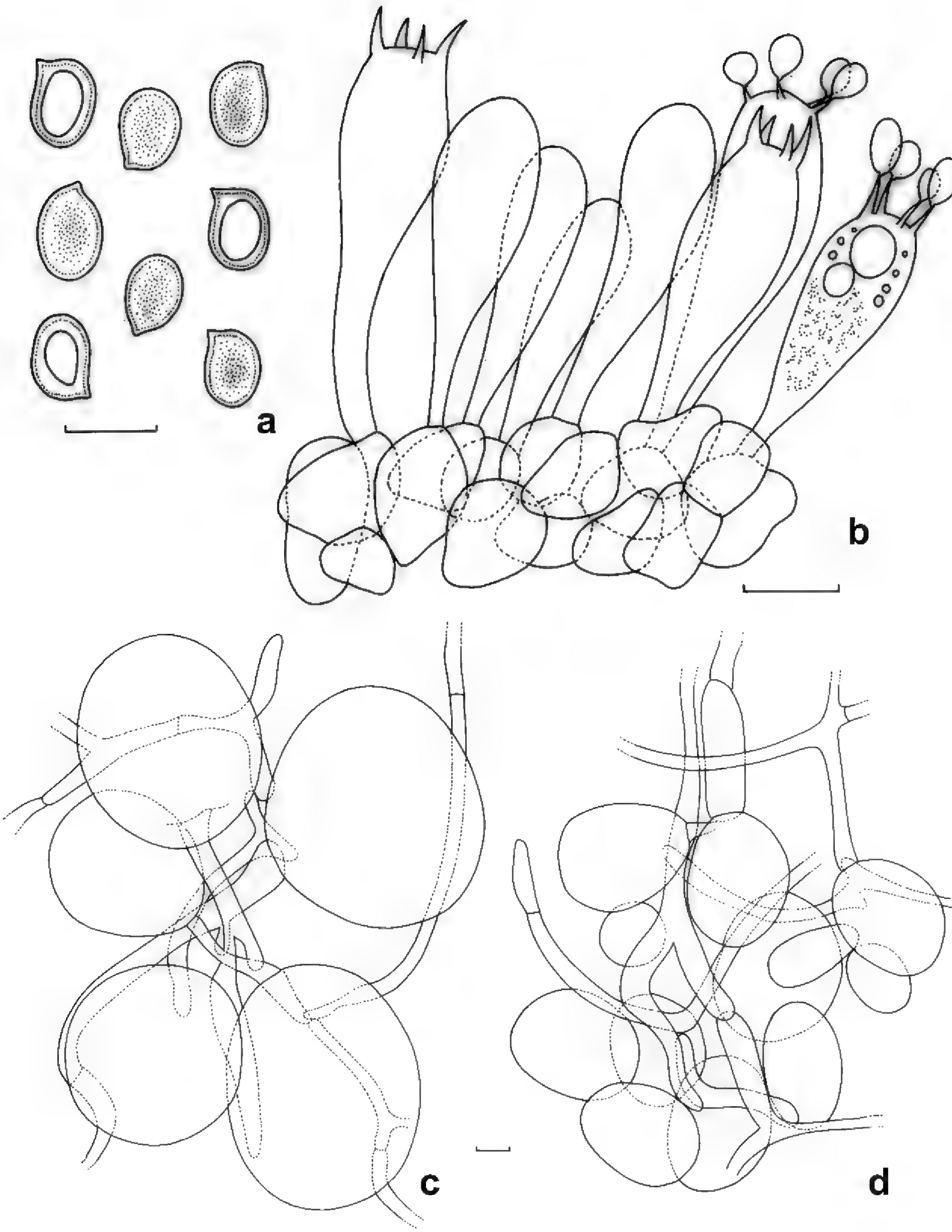

Figure 2: *Amanita coacta* (Menolli Jr. et al. 101). a. Basidiospores (guttulate or with precipitated internal content). b. Basidia and subhymenium. c. Universal veil remnants on pileus. d. Volval elements on stipe. Scale bars = 10 µm.

Such morphological differences can be more easily interpreted when there is a large collection from the same area, and one should not disregard the age of the basidiomata and environmental conditions such as recent rain, humidity

and desiccation. Preliminary molecular nLSU DNA sequence analyses of these collections (data not shown) support the position of *Amanita coacta* in section *Vaginatae* and imply a high similarity among different collections represented by specimens showing a certain degree of morphological variation (e.g., the absence or presence of patches on the pileus).

Amanita coacta is very similar to *A. craseoderma* Bas, also described from Amazonas State, but the latter has (sub)globose basidiospores and pigmented hyphae up to 25 µm wide in the pileipellis (Bas 1978).

The third species described for the same area is *A. crebresulcata* Bas (in section *Amanita*), which differs in having a saccate volva leaving no remnants on pileus. *Amanita crebresulcata* was previously reported for Parque Estadual das Fontes do Ipiranga by Grandi et al. (1984) as "*Amanita* sp. aff. *crebresulcata,*" based on a collection of Fidalgo & Furtado s.n. (SP46749) and by Pegler (1997) also based on SP46749 plus an additional collection, Pegler 3810 (SP214459). Collection SP46749 is poorly preserved, lacking both volva and stipe base, but it retains distinctive pileus patches, a feature that is not characteristic of *A. crebresulcata* and suggesting that the collection more properly represents *A. coacta*. A re-examination of SP214459 likewise demonstrated that it represents *A. coacta* and not *A. crebresulcata*. The records of *A. crebresulcata* for São Paulo State as reported by Grandi et al. (1984) and Pegler (1997) must thus be invalidated.

One other *Amanita* species may occur in this area, represented by a collection containing a single basidioma (07.IV.2005 M. Capelari s.n., SP). This specimen, which microscopically resembles *A. coacta* but differs in its macroscopic appearance, does not appear to have developed completely when collected; therefore, we cannot confirm whether it represents *A. coacta* or a different *Amanita* species.

Species of *Amanita* recorded from Brazil

In the available literature, nineteen taxa of *Amanita* are reported from Brazil. These species are presented in alphabetical order along with their reference of publication and distribution in Brazilian States (Table 1).

When Rick (1906) reported *A. spissa* (Fr.) P. Kumm. from Brazil, he also proposed two varieties for it: *A. spissa* var. *alba* Rick [nom. illegit., non Quél.] and *A. spissa* var. *laeta* Rick. Later Rick (1930, 1937, 1961) cited *A. strobiliformis* (Paulet ex Vittad.) Bertill. and *A. bresadolae* (Rick) Rick [nom. illegit., non Schulzer], all from Rio Grande do Sul State. When reviewing Rick's species, Singer (1953) renamed *A. bresadolae* as *Lepiota crassior* Singer but did not comment on the *A. spissa* varieties published by Rick in 1906. Bas & Meijer (1993) treated *A. spissa* var. *laeta* as a possible synonym of *A. grallipes* Bas & de Meijer described from Paraná State. There is no subsequent mention of *A. spissa*

Table 1: Species of *Amanita* recorded from Brazil, geographic distribution and references list.

Species	Distribution in Brazil[a]	References
Amanita ameghinoi (Speg.) Singer	SP	Pegler (1997)
Amanita campinaranae Bas[b]	AM	Bas (1978)
Amanita chrysoleuca Pegler	PR	Meijer (2006)
Amanita coacta[b]	AM, SP*	Bas (1978), Grandi et al. (1984) as *A. crebresulcata*, Pegler (1997) as *A. crebresulcata*
Amanita craseoderma[b]	AM, RO	Bas (1978), Capelari & Maziero (1988)
Amanita crebresulcata[b]	AM, PR, PE	Bas (1978), Meijer (2006) as "*A.* cf *crebresulcata*", Wartchow & Maia (2007)
Amanita grallipes[b]	PR, RS	Rick (1906) as "*Amanita spissa* var. *laeta*", Bas & Meijer (1993), Meijer (2001, 2006)
Amanita lanivolva Bas[b]	AM	Bas (1978)
Amanita lilloi Singer	PE	Wartchow et al. (2007)
Amanita muscaria	PR, RS, SC, SP	Homrich (1965), Fosco-Mucci & Yokomizo (1985), Figueiredo et al. (1996), Giachini et al. (2000), Meijer (2001, 2006), Giachini et al. (2004), Sobestiansky (2005)
Amanita pantherina var. *multisquamosa*	SC	Giachini et al. (2000, 2004)
Amanita phaea Bas (nom. prov.)[b]	AM	Bas (1978)
Amanita rubescens	RS	Sobestiansky (2005)
Amanita spissa	RS	Rick (1906, 1937, 1961)
Amanita spissa var. *alba*	RS	Rick (1906)
Amanita strobiliformis	RS	Rick (1930, 1937, 1961)
Amanita sulcatissima Bas[b]	AM	Bas (1978)
Amanita xerocybe Bas[b]	AM	Bas (1978)

[a] = Brazilian States: AM = Amazonas, PR = Paraná, PE = Pernambuco, SP = São Paulo, SC = Santa Catarina, RS = Rio Grande do Sul, RO = Rondônia; [b] = type locality in Brazil; * = species recorded in this work

var. *alba* in the literature, and recent authors consider this variety a nomen dubium, since there is neither indication of a specimen in Rick's publication nor preserved material. *Amanita spissa* and *A. strobiliformis* are European taxa that are not included in our key because they were cited only by Rick (1906, 1930, 1937, 1961) and probably do not occur in Brazil.

Amanitopsis plumbea Rick [nom. illegit., non (Schaeff.) J. Schröt.] is another problematic species described by Rick (1937) from Brazil. Bas (1978) studied the lectotype material (J. Rick 12.220, PACA) and considered this taxon as an insufficiently known species, since it was not possible to assign it to either *A. crebresulcata* or *A. coacta;* a third taxon may be involved.

Key to *Amanita* species occurring in Brazil

1. Basidiospores amyloid; pileal margin usually smooth, rarely sulcate-striate; short gills often attenuate .... (subgenus *Lepidella*) 2
1. Basidiospores inamyloid; pileal margin radially sulcate-striate; short gills nearly always truncate .... (subgenus *Amanita*) 7

2(1). Pileal margin not appendiculate; surface often deeply colored; basidiospores globose to ellipsoid, mostly < 10 µm, rarely up to 12 µm long; annulus membranous, rarely fugacious .... (Section *Validae*) 3
2. Pileal margin appendiculate; surface rarely deeply colored; basidiospores globose to bacilliform, rather often > 10 µm; annulus floccose to fugacious .... (Section *Lepidella*) 5

3(2). Pileus about 6 cm wide, convex to depressed when mature, white to pallid grayish with gray volval crust at center, viscid; basidiospores globose to subglobose, 5.5–7.5 × 5.5–6.5µm .... *A. campinaranae*
3. Pileus usually wider than 6 cm, conical, hemispheric-convex to plane- convex, rarely depressed 4

4(3). Pileus about 6.5 cm wide, conical, very dark brown with scattered small grayish warts and patches; stipe white above and gray below annulus, with scattered small volval warts; basidiospores characters unknown .... *A. phaea*
4. Pileus 6–12(–15), convex to applanate or finally depressed, reddish brown or more yellowish and paler, with more or less concentrically arranged whitish to grayish or grayish brown squamules; stipe whitish soon discoloring pinkish and concolor with pileus, with slight volval granulation; basidiospores ellipsoid, 7.5–10 × 4.5–5.5 µm .... *A. rubescens*

5(2). Pileus hemispherical or conic-convex to plane-convex, uniformly dark brown to somewhat paler grayish brown .... *A. grallipes*
5. Pileus subglobose or hemispheric to plane-convex white to pale pinkish orange or light beige with patches 6

6(5). Pileus narrower than 4 cm, usually about 2–4 cm; basidiospores subglobose to broadly ellipsoid, mostly < 10 µm, about 7.5–9.5 × 6.5–7.5 µm, basidia 4-spored .... *A. lilloi*
6. Pileus usually wider than 4 cm; basidiospores ellipsoid, rather often > 10 µm, about 11–13 × 8–10 µm, basidia mostly 2-spored .... *A. ameghinoi*

7(1). Stipe with a bulbous base; volva usually friable, sometimes limbate; annulus absent or present .... (Section *Amanita*) 8
7. Stipe without basal bulb; volva saccate to sub-membranous-felted, more rarely friable; annulus absent .... (Section *Vaginatae*) 13

8(7). Pileus often red, orange or yellow covered with white or yellowish patches or flocculose-pulverulent velar remnants 9
8. Pileus brown, ochraceus brown, brownish, whitish to grayish, covered with gray, white to grayish or brownish ochraceus warts and patches 10

9(8). Pileus 8–18(–25) cm wide, light orange to deeply red, with white patches; basidiospores ellipsoid, 9–11.5 × 6–8 µm .... *A. muscaria*

9. Pileus 2.5–3.5 cm wide, dry, deep chrome yellow to orange-yellow, covered with yellowish ochraceous, flocculose-pulverulent velar remnants; basidiospores subglobose to ellipsoid, 7–9.5 × 4.5–6 µm .... *A. chrysoleuca*

10(8). Clamps absent; pileus 4–6.7 cm wide, sordid whitish to ochraceus with brownish ochraceus center; basidiospores globose to subglobose, 8–9 × 7.5–9 µm .... *A. xerocybe*

10. Clamps present; pileus about 4 cm wide 11

11(10). Annulus fragmentary .... *A. pantherina* var. *multisquamosa*

11. Annulus always absent 12

12(11). Volva saccate, membranous, gray-brown, enclosing one-quarter to one-third of stipe like a sock .... *A. lanivolva*

12. Volval remnants at base of stipe arising from upper part of bulb, appressed, pale brownish-gray, with subtomentose-sublanose surface, at one side of stipe forming a thin submembranous limb above bulb .... *A. sulcatissima*

13(7). Volva friable, forming a dark gray-brown sub-floccose belt at base of stipe and evanescent small dark brown warts on cap .... *A. craseoderma*

13. Volva saccate or submembranous-felted, white to pale buff or grayish, felted to, at most, appressedly fibrillose on outside limb 14

14(13). Volva membranous, narrowly saccate, white, leaving no remnants on pileus; basidiospores subglobose to broadly ellipsoid, rarely ellipsoid, (8–)8.5–10(–11) × (6.5–)7–8.5(–9)µm .... *A. crebresulcata*

14. Volva felted sub-membranous, tending to break up into small appressed flat gray patches at stipe base and around cap center; basidiospores subglobose to broadly ellipsoid, 8.7–10(–11.2) × (6.2–)7.5–8.7(–10) µm .... *A. coacta*

According to the classification of Corner & Bas (1962), the Brazilian species are distributed in the two subgenera *Amanita* and *Lepidella* and in four sections *Amanita*, *Vaginatae*, *Validae*, and *Lepidella*. The infrageneric classification of *A. lanivolva* should be regarded with caution, however. Bas (1978) first treated this species in section *Vaginatae* based on its possession of a saccate volva. Simmons et al. (2002) later emphasized the presence of a small, but distinct basal bulb in collections of Guyana to refer *A. lanivolva* to section *Amanita*, although the presence of a saccate volva is uncommon within the section.

Of the new species described by Bas (1978), only *A. craseoderma* (Capelari & Maziero 1988) and *A. crebresulcata* (Meijer 2006, Wartchow & Maia 2007) have been found and mentioned outside Amazonas State. Simmons et al. (2002) also recorded *A. lanivolva* and *A. xerocybe* from Guyana.

According to Bas (1978), a provisional name was given for *A. phaea*, because basidiospores were lacking in the type material; other characters, such as a smooth and non-appendiculate pileus margin, friable volva, and attenuate lamellulae, are enough to classify it in the section *Validae*.

The results of this paper strongly support the necessity of collecting and studying *Amanita* in South America because very little is known about its neotropical species.

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Two new boreal species of *Tricholoma* from Fennoscandia

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Abstract— Two new species of *Tricholoma* are described from the boreal part of Fennoscandia. *Tricholoma guldeniae* is based on *T. luridum* sensu Nordic auct. Morphologically it belongs to the *T. sejunctum* group, but it is characterised by a greyish yellow cap, and large, irregular spores. *Tricholoma olivaceotinctum* is based on *T. squarrulosum* sensu Nordic auct. It is closely related to *T. squarrulosum,* but differs by growing with conifers and by having a distinct greenish-olive tint on the cap. Based on our present knowledge, these locally rather frequent species are endemic to North Europe (including Scotland). The identity of both species is supported by information from ITS sequencing. Descriptions, keys, and information on distribution and ecology of the new described species are given in the present paper.

Key words—*Agaricales*, boreal forest

Introduction

Even though the euagaric genus *Tricholoma* is well known by most European mycologists, it still contains several species groups that are rather poorly resolved with regard to taxonomy and nomenclature. One reason for this is the persistence of different mycological traditions in various parts of Europe. In Scandinavia, the mycological tradition of Elias Fries and co-workers in the 19th century was continued into the 20th century by Nordic mycologists including A. Blytt, P.A. Karsten, J.E. Lange, and S. Lundell, works that still provide an important basis for contemporary Nordic taxonomy. Due to their status as sanctioning works in the Vienna Code (McNeill et al. 2006), Systema Mycologicum and Elenchus Fungorum published by Elias Fries (1821-32) play a crucial role for the interpretation of classical fungal epithets. Fries applied many epithets proposed by authors from central and western (i.e., non-boreal) Europe including Persoon, Schaeffer, and Bulliard. In many cases

Fries interpreted these names in agreement with their original meaning, but in others, the Friesian interpretation is not consistent with the original intention. This is not least the case for a number of boreal taxa for which Fries wrongly applied epithets based on fungi described from central and western Europe. In many cases Nordic mycologists have persisted in interpreting such epithets in agreement with Fries, while mycologists from other parts of Europe have used them for more southern species in agreement with their original authors. As a consequence many classical fungal epithets are interpreted differently in various parts of Europe. Studies of type specimens and specimens from different parts of Europe are necessary in the solution of such conflicting interpretations. The present work is a small contribution in this process suggesting new names for two northern *Tricholoma* species that have been well known but wrongly named by Nordic mycologists for many decades. The study is based on studies of fresh and herbarium material of *Tricholoma* species from several countries across Europe to secure an identical use of epithets across the continent.

Materials and methods

Fresh specimens of *Tricholoma* species have been studied in Denmark, Finland, France, Great Britain, Italy, Norway, Slovakia, Slovenia, Sweden, and Switzerland. In addition herbarium material has been obtained from several herbaria across Europe and USA (BG, C, E, GB, H, Kuopio, LUG, M, NYS, O, OULU, TRH, Tromsø, TURA, TUR, S, UPS, A. Riva's private herb. and M. Bon's private herb.). All relevant available type collections have been studied.

Descriptions of both fresh and dried collections follow the terminology used in Bas et al. (1988). Colour descriptions follow Kornerup & Wanscher (1969).

Of all critical collections at least 20 spores were measured at 1000–2000× magnification; other microscopical characters were studied following less strict rules. Spores were measured mostly from mounts of the hymenium. Dry material was mounted in 3–5 % KOH. For each species the number of spores measured is indicated in square brackets followed by the number of collections from which these measurements have been taken. Spore dimensions are indicated as a range with the extremes in brackets. The length/width ratio (Q) is also given as a range. The ranges of the averages for both dimensions and the Q value are also mentioned.

ITS sequence data of the holotypes of *Tricholoma guldeniae* and *Tricholoma olivaceotinctum* were produced for this study and the sequence data sent to GenBank. DNA was extracted, amplified, and sequenced according to the methods in Frøslev et al. (2005). ITS data were compared to sequence data available from sequence data from all *Tricholoma* specimens available on GenBank as well as to unpublished sequences by the present authors with simple neighbour-joining and parsimony methods (data not shown).

Tricholoma guldeniae Mort. Christ., **sp. nov.**

MycoBank MB 512781; GenBank FJ544860

Misapplied: *Tricholoma luridum* (Schaeff.) P. Kumm., sensu Nordic auct. (Gulden 1969: p. 70, Salo et al. 2005: p 769.)

Pileus 50–80(–100) mm, campanulatus us que ad convexus cum umbone, cinereo-luteus, sericeus us que ad subsquamulosus. Lamellae emarginatae, albidae, acie saepe lutea. Stipes 40–100 × 9–20 mm, albidus, subfibrillosus. Caro alba, odore et sapore farinoso. Sporae 7.5–10.5 × 6.0–7.8 µm, Q = 1.0–1.6, in magnitudine et forma heterogenea, laeve, hyalinae, non-amyloideae. Basidia 37–45 × 8.5–11.0 µm, 1, 2, 3, 4-sporia. Pileipellis cutiformis. Fibulae absentes. In sylvis coniferarum.

Holotypus: *Norway, Akershus, Nannestad, Hornsjøen, leg. G. Gulden, 08.09.1995 (n° MC95-103) in herbario C (Copenhagen).*

Etymology: *guldeniae* (Latin), in honour of Gro Gulden.

Pileus 50–80(–100) mm, at first campanulate or conical with deflexed margin, later convex to plano-convex with a small, sometimes pointed umbo, finally applanate with straight or reflexed margin, which is sometimes radially splitting, innately fibrillose to finely squamulose, with grey-brown or greyish yellow fibrils or squamules on a pale yellowish or whitish background, darkest in centre, dry to rarely faintly viscid. Lamellae adnate to emarginate, medium to rather distant, whitish or with a slight greyish or yellowish tinge, edge serrulate, sometimes yellowish. Stipe 40–100 × 9–20 cm, cylindrical or gradually tapering towards base or apex, whitish or pale yellowish, smooth or innately fibrillose, but often shining when dry. Context whitish or slightly watery grey or yellowish in pileus or stipe; smell weakly farinaceous; taste farinaceous, mild.

Spores [1298, 67] (6.8–)7.5–10.5(–11.5) × (4.8–)6.0–7.8(–8.5) µm, average: 7.4–9.3 × 5.9–7.4 µm, Q= 1.0–1.6, average: 1.1–1.4, very heterogeneous in size and shape, some large and subglobose, others ellipsoid, smooth, hyaline and non-amyloid. Basidia 37–45 × 8.5–11.0 µm, 1-, 2,- 3- or 4-spored, normally all types occur in a single basidiocarp. Pileipellis a cutis of parallel hyphae with rather short segments, hyphae approximately 15–30 × 5–8 µm, rather strongly incrusted with brownish or yellowish pigment. Subpellis of inflated hyphae 20–50 × 6–15 µm, only weakly incrusted. Clamp connections absent.

Distribution and Ecology — *Tricholoma guldeniae* is most frequent along the west coast of Norway and in coastal areas of SE Norway. It is one of the most frequent tricholomas in the natural spruce forest enclave of the Voss district, W Norway (T.E. Brandrud pers. obs.). In this region, it also occurs widespread in spruce forest plantations outside the natural distribution of spruce, e.g. in the Bergen area. In Sweden it is rather frequent only in the southwestern parts and only a few collections are known from Finland. Outside Fennoscandia it is at present known only from Scotland.

The species is most frequently collected in moist or submesic ± calcareous *Picea* forests. 63 percent of the 27 collections with ecological notes belong to this type of habitat. The species is also recorded from more acidic habitats. A few collections are from forests with *Pinus*, *Quercus*, *Betula*, *Populus*, or *Corylus* often in mixed stands, but it is unclear whether the species forms mycorrhiza with any of these hosts. The species seems to be one of few strongly oceanic spruce forest associates.

Selected collections: **Norway:** Akershus, Nannestad, Hornsjøen, 08.09.1995, G. Gulden, (holotype, M. Christensen 95-103), (herb. C); Buskerud, Hole, Krokskogen, 09.09.1957, Sundbye, Sverre G., (herb. O); Hedmark, Kongsvinger, Kongsvingertraktene, 22.09.1967, G. Ånerud, (herb. O); Hordaland, Bergen, Stend, 11.09.1966, K. Hvoslef, (herb. O); Møre og Romsdal, Molde, Hovdenakken, 03.09.1982, J. A. Vaagsæter, (herb. O); Nord-Tr¢ndelag, Namsos, Mellom Kleppen og Høknesmyrene, 08.10.1967, J. Stordal, (JS 12549), (herb. O); Nordland, Rana, Hammernes, 08.09.1976, H. Folkmar, (G. Gulden 46a/76), (herb. O); Oppland, Jevnaker, NW of Mylla, 28.09.1969, P. Wassum, (herb. O); Oslo county, Oslo, Høybråten,, 08.08.1963, G. Gulden, (GG 130), (herb. O); Rogaland, Sandnes, Lutsi, 16.08.1953, J. Stordal, (JS 8872), (herb. O); Sør-Tr¢ndelag, Trondheim, Elsterparken, 29.08.1951, Eriksson, (JS 6569), (herb. O); Vest-Agder, Lyngdal, Lyngdal, 10.09.1959, J. Stordal, (herb. O); Vestfold, Våle, Hengsrud, 26.09.1981, Course, (herb. O); Østfold, Fredrikstad, Ulfeng, 02.09.1973, W. Ramm, (herb. O) - **Sweden:** Göteborg, Botaniska Trädgården, Arboretet, 29.08.1977, S. Jacobsson, (SJ 77199), (herb. S); Skåne, Vånga, Skärsnäs, 23.09.1982, L. Örstadius, (LÖ 325-82), (herb. L. Örstadius); Västmanland, Guldsmedshyttan, vid Leja gård, 11.09.1994, H. Kaufmann, (HK 94035 A), (herb. S) - **Finland:** Uusimaa, Pornainen, Laukkoski, Sopenmetsä, vanha kuusimetsä, 05.10.1991, P. Höijer, (herb. H); Varsinais-Suomi, Koski T. l., Hongisto, 29.09.1991, P. Heinonen, (PH 299-91), (herb. TUR) - **Great Britain — Scotland**: Loch Habor S of Pass of Gencae E of Allt Lairis Eilde, 20.09.1993, J. Schreurs, (Schreurs 796), (herb. L).

Discussion — *Tricholoma guldeniae* can be distinguished from other species resembling *T. sejunctum* by the large but heterogeneously sized spores and the greyish yellow, non-viscid pileus. According to our ITS analysis (results not shown), *T. guldeniae* belongs to the core clade of *Tricholoma* and seems most closely related to *T. columbetta*, *T. equestre* and *T. umbonatum*.

Gulden (1969) applied the name *Tricholoma luridum* to the species. *Tricholoma luridum* was, however originally depicted and described by Schaeffer (1762, plate 69) and later named as *Agaricus luridus* in Schaeffer (1774). The description was accompanied by a painting, which shows a cluster of fungi with convex, greyish yellow pilei and greyish lamellae. The plate seems close to the interpretation in the tradition maintained in more southern parts of Europe (Kühner & Romagnesi 1953, Riva 1998, Bon 1991; see further comments on this taxon below).

Fries did refer to *Agaricus luridus* Schaeffer in his sanctioning work (Fries 1821, page 40) but also to *Agaricus luridus* Persoon (Fries 1821, page 65). The latter was later combined into *Lactarius* by Gray (1821), and is still accepted as

a good *Lactarius* species (e.g. Heilmann-Clausen et al. 1998). Being published in 1801 *Agaricus luridus* Persoon is, however, a later homonym of *Agaricus luridus* Schaeffer, and hence an illegitimate name. Thus, *Lactarius luridus* needs to be renamed, unless another valid name can be traced for this taxon. In his later publications (Fries 1838, 1874) Fries placed *Agaricus luridus* Schaeffer in his section *Tricholoma*. However, Fries's description indicates that he confused this taxon with his own interpretation of *Agaricus sejunctus* (which differs from the original *Agaricus sejunctus* in the sense of Sowerby), which we consider a synonym to *Tricholoma arvernense* Bon (e.g. Christensen & Heilmann-Clausen 2008). Fries never mentioned any microscopical details, but an unpublished painting of *Agaricus luridus* at the Natural History Museum in Stockholm made under supervision of Fries fits very well with *T. arvernense*. Karsten (1899), who followed the tradition of Fries, also used the name *T. luridum* for *T. arvernense*. His description and three collections in the herbarium in Helsinki support this. The first unambiguous description of our *T. guldeniae* thus seems to be that presented by Gulden (1969, sub nom. *T. luridum*).

According to the protologue of Schaeffer (1774), and the prevailing interpretation in Europe south of Fennoscandia, the true *T. luridum* is a compact and rather small *Tricholoma* species with a convex, dark grey pileus almost lacking yellow greenish tinges, distant, thick, grey or greyish lamellae, and large, but uniform ellipsoid spores (7.8–10.3 × 4.8–7.3, average 8.6–9.6 × 6.2–6.6, Q=1.3–1.6, average 1.4–1.5) from 4-spored basidia only (description based on collections from France, Switzerland and Austria). *Tricholoma luridum* is widespread in Europe south of Fennoscandia in both coniferous and deciduous forests. Bon (1984) mentions *Abies* and *Picea* as the primary hosts while Riva (1998) mentions coniferous and mixed forests with *Fagus* as habitat. The species has never been recorded from Fennoscandia, but could be expected to occur in the southernmost parts, as there are scattered records of the species through Germany.

Key to the species resembling *T. guldeniae* in northern Europe:

1. Spores small (4–6 × 3–5 μm), most hyphae in pileipellis with clamp connections, pileus in mature basidiocarps straw-yellow or brownish yellow without greenish colours .... *T. arvernense*
- Spores longer (> 6 μm), hyphae in pileipellis without clamp connections, but basal clamp connections at the basidia sometimes present, pileus with or without greenish colours 2
2. Stipe more or less squarrulose, colour of pileus olive-green, olive-brown or golden-brown 3
- Stipe glabrous or slightly fibrillose, colour of pileus yellow, greenish or greyish 4

3. Basidiocarps slender, pileus olive-green, olive-brown or blackish olive, spores subglobose (7–8.5 × 6–7 µm), basidia without clamps .... *T. fucatum*
- Basidiocarps stout, pileus golden brown, spores ellipsoid (6–7 × 4.5–5 µm), basidia sometimes with clamps. .... *T. joachimii*

4. At least some spores very large (length > 8.5 µm), pileus pale greyish green or dark olive green. 5
- All spores smaller than 8.5 µm, pileus with yellow green colours, with or without dark blackish innate fibrils 6

5 Spores homogeneous in size (8–10 × 5–7 µm), basidia 4 spored, pileus often viscid, lamellae greyish to grey, distant, under deciduous and coniferous hosts in Europe south of Fennoscandia .... *T. luridum*
- Spores heterogeneous in size and shape, but at least some spores very large (7–11 × 6–8.5 µm), basidia 1, 2, 3 or 4 spored, pileus normally non-viscid, often with pale greyish innate fibrils, lamellae whitish or pale greyish, under conifers in Fennoscandia and Scotland......................... *T. guldeniae*

6. In deciduous forest, pileus greenish or yellowish, (spores 6–7.5 × 5–6 µm) ....*T. sejunctum*
- In coniferous forest, pileus greyish yellow-green or brownish yellow with innate blackish fibrils, (spores 6–8.5 × 5–7 µm).............. *T. viridilutescens*

Tricholoma olivaceotinctum Heilm.-Claus. & Mort. Christ., **sp. nov.**

MycoBank MB 512781 GenBank FJ544861

Misapplied: *Tricholoma squarrulosum* Bres., sensu Nordic auct. (Ryman & Holmåsen 1984, Hansen & Knudsen 1992, Salo et al. 2005)

Pileus 38–75(–120) mm latus, hemisphaericus usque ad convexus cum umbone, fumosus-viridifuscus squamulosus. Lamellae emarginatae, albidae-cinereae. Stipes 30–80 × 6–20 mm, albidus-cinereus, subfibrillosus-subsquamulosus. Caro alba. Odor dulcidulus et farinosus. Sapor farinosus. Sporae 4.0–6.7 × 2.8–4.9 µm, Q=1.1–1.8, laeves, hyalinae, non-amyloideae. Basidia 18–27 × 5–7 µm, 4-sporigera. Pileipellis trichodermis. Fibulae absentes. In sylvis coniferarum.

Holotypus: *Sweden, Jämtland, 5 km SE of Brunflo, leg. M. Christensen 04.09.1997, (n° MC97-103) in herbario C (Copenhagen).*

Etymology: *olivaceotinctum* (Latin) = with olivaceous colours, referring to the colours at the cap margin.

Pileus 38–75(–120) mm, at first convex, hemispherical or obtusely conical, expanding to broadly applanate or even planoconcave, typically retaining a small umbo, densely covered by small, very distinct, dark olivaceous brown to black, recurved scales on a cream to olivaceous grey background, olivaceous colours normally distinct, especially in young specimens, which may be almost sulphur yellow at the edge. The scales are often forming a confluent dark spot in the centre. Lamellae emarginate, rather narrow to normal, normal to rather dense, almost white to pale greyish, often with a faint olivaceous tinge, sometimes with small black spots. Stipe 30–80(–150) × 6–20(–30) mm,

cylindrical, mostly distinctly swollen at base, white to pale brownish grey or pale olivaceous grey, smooth or slightly greyish fibrous to scaly at apex. Context soft, brittle to rather elastic, often hollow in stem, whitish to pale olivaceous grey, sometimes becoming darker upon exposure. Smell weak, but distinctly spicy, sweetish, reminding of honey often intermixed with pepperish components, after cutting faintly to strongly farinaceous. Taste mild to slightly bitter, distinctly farinaceous.

Spores hyaline [170, 8], 4.0–6.7 × 2.8–4.9 µm, average 5.0–5.7 × 3.5–4.1 µm, subglobose to oblong, Q = 1.1–1.8, average = 1.36–1.54. Basidia 18–27 × 5–7 µm, 4-spored. Pileipellis a cutis of ± parallel hyphae breaking up in curved, trichoderm scales, hyphae (13–)17–50(–75) × 7.5–15(–22) µm, partly incrusted with brownish or blackish pigment. Clamp connections absent.

Distribution and Ecology — *Tricholoma olivaceotinctum* is confined to moist *Picea* stands mostly on somewhat calcareous soils. It is widely distributed in Fennoscandia, but is generally rare, with most records from the lime-rich soils in the provinces of Medelpad and Jämtland in central Sweden. According to Salo et al. (2005, sub nom. *T. squarrulosum*) it is more or less restricted to old-grown stands in Finland, which agrees with our personal experience from Norway and Sweden. It seems to be a truly boreal taxon, restricted to the natural *Picea* forest zone in central and northern Fennoscandia. The species is red-listed in Finland, Norway, and Sweden (Gärdenfors 2005; Salo et al. 2005; Kålås et al. 2006; sub nom. *T. squarrulosum*). We know of no collections south of central Sweden and southern Norway and consider it unlikely that it should occur together with the true *T. squarrulosum* in any kind of habitats in Europe.

Collections examined: **Norway,** Oppland, Nordre Land, Øst-Torpa, Røste N. of Kinn Church, 12.09.1984, leg. B. Wasstorp (S); **Sweden,** Jämtland, Brunflo, Tandsbyn, 02.09.1997, leg. J. Heilmann-Clausen, JHC97-131 (C); Jämtland, 5 km SE of Brunflo, 04.09.1997, leg. M. Christensen MC97-103 (C); Jämtland, Fillstabäcken, 02.09.1997, leg. K. Olofsson, JHC97-145 (C); Jämtland, parishes of Mörsil & Mattmar, 23.08.1979, leg. Nils Hakelier, (UPS); Jämtland, Mattmar parish., Storbodarna, 16.08.1984, leg. S. Ryman (UPS); ibid 27.08.1978, leg. N. Hakelier (S); Jämtland, Mattmar, ca. 1 km SO of Mattmars station, 29.08.1978, leg. N. Hakelier (S); Jämtland, Mörsil, Ris, 30.08.1978, leg. N. Hakelier, (S); Jämtland, Mörsil, Sällsjö, 19.08.1978, leg N. Hakelier, (S), ibid. 01.09.1981, leg. O. Persson & L. Lundberg, (UPS); ibid. 15.08.1984, Å. Strid 17341 (S); Jämtland, Alsen, between Glösa and Hallängden, 24.08.1978, leg. N. Hakelier, (S); Lappland, Åsele Lappmark, Dorotea, N. of V. Ormsjö, leg. K. Jaederfelt, 21.08.1990, (S); Lappland, Åsele Lappmark, Risbäck, S slope of Arksjöberget, 29.VIII.1993, leg. K. Jaederfelt (S); Medelpad, Borgsjö, Bergåsen, 13.09.1995, leg. M. Christensen, MC95-135 (C); ibid, 13.09.1995, leg. J. Heilmann-Clausen, JHC95-050 (C); Medelpad, Borgsjö, Julåsen, 15.09.1997, leg. J. Heilmann-Clausen, JHC95-070 and 071 (C); Medelpad, Borgsjö, 1 km N of Annalund, 01.09.1993, leg. B. Hagman (S); Norrbotten, Piteå parish, Sjulsmark, Bastabäcken. 14.09.1985, leg. B. Öster (S); Uppland, Lagga parish, 1 km SW of Lingsberg, 14.V.1977, leg. N. Lundqvist (UPS).

Discussion — *Tricholoma olivaceotinctum* has long been known under the name *T. squarrulosum* in Fennoscandia (e.g. Ryman & Holmåsen 1984, Gulden 1992, Salo et al. 2005). This is understandable since both the present species and the true *T. squarrulosum* share important macroscopical characters, i.e. the blackish squamulose pileus in combination with a pale greyish to dark brownish grey stipe. After field studies in different parts of Europe, we realised that the species occurring in boreal coniferous forests in Scandinavia clearly differs morphologically from the species occurring mainly in broadleaved forests from southern Scandinavia to the Mediterranean zone. The separation is well supported by ITS sequence patterns (results not shown).

Tricholoma squarrulosum was originally described by Bresadola (1892) from Trento in Italy, and in southern Europe the name is consistently used for a rather common *Tricholoma* species with blackish scales on the cap and stem, large spores and an occurrence mainly in thermophilous *Quercus* forests (e.g. Bon 1984, 1991, Riva 1988). We see no reasons to doubt this interpretation of the original concept of Bresadola. We have studied the type of *T. squarrulosum*, which is in fairly good condition. It is macroscopically similar to our own dried specimens of this species and the spores are long (6.5–8.5 × 3.5–4.5 µm), in agreement with our own material.

Tricholoma squarrulosum occurs also in thermophilous deciduous forests in central and northwest Europe, north to Denmark, south Sweden and England, where it is often referred to as *T. atrosquamosum* (e.g. Noordeloos & Christensen 1999). We consider this interpretation of *T. atrosquamosum* to be inconsistent with the original intention of the epithet. According to the protologue of Chevalier (1837), *Agaricus atrosquamosus* occurs in mossy mountainous forests ("inter muscos in sylvis montosis Hercyniae") and the iconotype (no type specimen has been found) depicts a *Tricholoma* species with a pale, smooth stipe. We find this to be consistent with the interpretation of *T. atrosquamosum* by several authors in central and northern Europe (e.g. Gulden 1969, Dähncke & Dähncke 1979), and consider *T. atrosquamosum* to be a sister taxon to *T. orirubens*, with weaker colour reactions and a restriction to coniferous forests (Christensen & Heilmann-Clausen 2008). Preferably a neotype should be collected in southern Germany to stabilize the interpretation of this name.

We have found no indication that Elias Fries was familiar with *T. olivaceotinctum*. This probably reflects that the species was lacking or very rare in his collecting grounds around Femsjö and later Uppsala. Even in other classical mycological works from the Nordic countries we have not come across any other taxa matching with the species. Therefore we find it necessary to describe the species as new.

Macroscopically, *T. olivaceotinctum* resembles *T. squarrulosum*, but it is distinguished by differences in ecology and distribution, and by having more slender basidiocarps with distinct olivaceous tinges, especially at the cap margin. Microscopically it is distinguished by having comparably small spores. The species may even be confused with *T. atrosquamosum*, which may occur in quite similar habitats. From this species *T. olivaceotinctum* is best separated based on the distinctly greyish or brown stipe and olivaceous colours at the cap margin. Furthermore, *T. atrosquamosum* is mainly a southern boreal species in Fennoscandia and the zone where these two taxa co-occur is limited.

Key to species resembling *T. olivaceotinctum* in northern Europe:

1. Stem white, ± shiny, sometimes with discrete, scattered blackish scales, often becoming blue-green and/or magenta in basal part after picking; smell sweetish, like honey or of cedar wood (farinaceous when cut) 2
- Stem pale greyish or brownish smooth or with a dense covering of dark scales or fibrils, often becoming reddish in basal part after picking; smell aromatic spicy, like pepper (farinaceous when cut) 3

2. Mycelium yellow; cap felty or scaly, but scales not strongly recurved; with or without strong contrast between scales and exposed flesh; under *Fagus*, *Quercus*, *Tilia* and *Corylus*, (spores 4–7 × 3–5 µm) . . . *T. orirubens*
- Mycelium white; cap with distinct, upright and recurved scales strongly contrasting the white flesh; under conifers, (spores 4–7 × 3–4.5 µm). . . . . *T. atrosquamosum*

3. In herb rich, mossy *Picea* forests, often on damp calcareous or mesotrophic soils; cap with a distinct olivaceous tinge, especially at margin; spores 4–6 × 3–5 µm. . . . . *T. olivaceotinctum*
- In thermophilic deciduous forests, mainly on dry, calcareous soils; cap without a distinct olivaceous tinge; spores on average > 5.5 µm long 4

4. Cap margin whitish woolly in young basidiocarps; flesh only weakly reddening in stem base, (spores 6–8 × 4–5.5 µm) . . . . *T. squarrulosum*
- Cap margin almost smooth, even in young basidiocarps; flesh strongly reddening in stem base and often in entire basidiocarps after handling, (spores 5–7 × 3.5–5 µm). . . . . *T. basirubens*

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Pestalotiopsis theae (*Ascomycota*, *Amphisphaeriaceae*) on seeds of *Diospyros crassiflora* (*Ebenaceae*)

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Abstract — Among fungal isolates from seeds of *Diospyros crassiflora*, one showed cultural and microscopic features of *Pestalotiopsis* species. DNA-sequence comparison and phylogenetic analyses using nucleotide sequences of internal transcribed spacer (ITS1-5.8S-ITS2) and the portion of nuclear large subunit (nuc-LSU) rDNA identified it as *Pestalotiopsis theae*. This finding indicated that *Pestalotiopsis theae,* a common pathogen that is often an endophyte or saprobe, may also be seminicolous.

Key words — acervuli, conidia, ribosomal RNA, seminicolous fungi

Introduction

Species of *Pestalotiopsis* Steyaert (*Xylariales*, *Xylariomycetidae*) form a cosmopolitan complex of fungi, which are economically important as agents of plant diseases (Chakraborty et al. 1994, Tuset et al. 1999, Nagata et al. 1992, Koh et al. 2001) and producers of pharmaceutical substances (Li et al. 1996, Strobel 2002). Besides the parasitic lifestyle, *Pestalotiopsis* species are also endophytes on living leaves and twigs but some are also saprobes often isolated from dead plant matter and even soil (Agarwal & Chauhan, 1988) and in plant debris (Osono & Takeda 2000).

In the Mbalmayo Forest Reserve, Cameroon, investigations were carried out to determine the diversity of fungi growing on seeds, termed seminicolous, of *Diospyros crassiflora* Hiern (*Ebenaceae*). Fungal isolates obtained were identified on the basis of cultural characteristics and molecular analysis. In addition to some *Trichocomataceae* species commonly known to be seminicolous — such as *Penicilliopsis clavariiformis* Solms and *Penicillium* spp. — one isolate had culture characteristics and micromorphology that related it to *Pestalotiopsis*. The aim of this study was to identify this isolate and to demonstrate the seminicolous character of *Pestalotiopsis*.

Materials and methods

Isolation, culture, and microscopic examination

During the fruiting period, unripe and ripe fruits of *D. crassiflora* were collected in the Mbalmayo Forest Reserve, Cameroon (Douanla-Meli 2007). Fresh seeds were removed from fruit, were surface-sterilized by dipping in 70% ethanol for 10 minutes, rinsed in deionised water, then were transversally divided. With aseptic scalpel, pieces of kernel (3 mm long) were cut up and placed on MYP (Malt Yeast Agar) medium containing 1% Tetracycline for avoiding bacterial growth, and incubated at room temperature. The hyphal tips emerging from seed pieces were cut and placed in new MYP Petri dishes without antibiotics. Pure colonies were subcultured on MYP and synthetic low-nutrient agar (SNA, Nirenberg 1976) in the light at room temperature and with 12 hours cool, white, fluorescent light and 12 hours of darkness at 25 °C. Microscopic features were studied from colony grown on MYP, mounted in 5% KOH. Conidia were photographed using Color View I Digital Camera. Colour terms in parentheses are those of Kornerup & Wanscher (1978).

DNA isolation and phylogenetic analyses

Genomic DNA was extracted from 5 days old culture grown at 25 °C on MYP using the CTAB method (Gardes & Bruns 1993). The primer pairs ITS1f/ITS4 (White et al. 1990) and LR0R/LR5 (Vilgalys & Hester 1990) were used for both PCR and sequencing of ITS1-5.8S-ITS2 and the portion of nuc-LSU rDNA respectively as described in Douanla-Meli et al. (2005) and Douanla-Meli & Langer (2008). New sequences have been deposited in GenBank with accession numbers EU833969 (nuc-LSU) and EU833970 (ITS). Additional sequences of *Pestalotiopsis* and allied species were retrieved from GenBank, the names and accession numbers are recorded on phylogenetic trees. The sequences were aligned in ClustalX (Thompson et al. 1977). Phylogenetic analyses were executed in PAUP* 4.0b10 (Swofford 2002) and used maximum likelihood (ML) with appropriate model determined by MrModeltest 2.2 (Nylander 2004). Tree topologies were tested with Kishino-Hasegawa (K-H) (Kishino & Hasegawa 1989) and Shimodaira-Hasegawa (S-H) (Shimodaira & Hasegawa 1999) maximum likelihood examinations. Pair differences among sequences were estimated using the "pairwise base differences" option in PAUP*.

Results and discussion

Phylogenetic analyses

The ITS and nuc-LSU rDNA sequences of the isolate DMC 698a had 559 and 910 bp respectively. In BLAST searches the ITS sequence showed 100% similarity with *P. theae* (Sawada) Steyaert strain PSHI2004Endo80 and

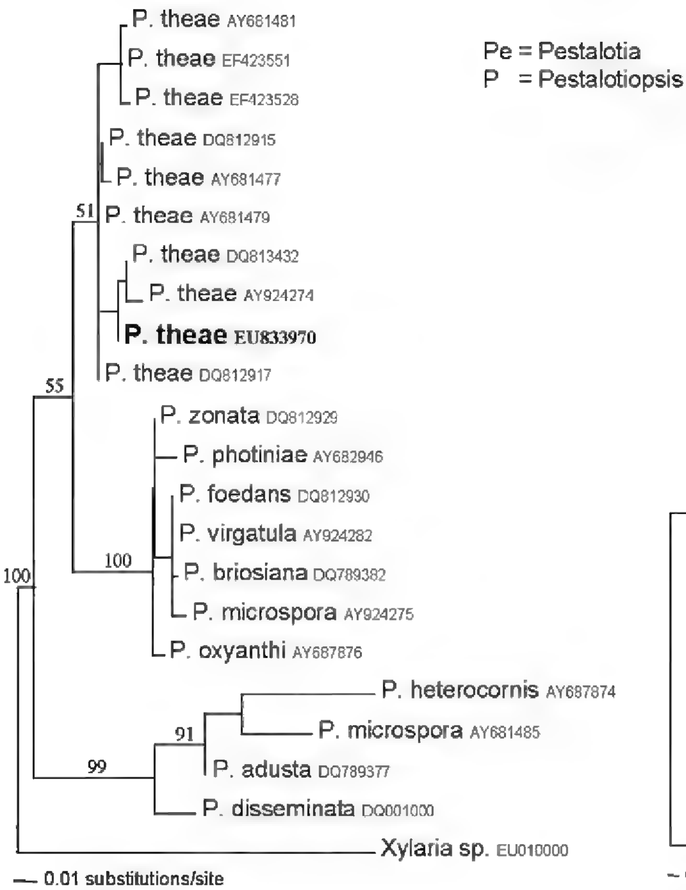


FIGURE 1. Phylogram of one of the 12 MLTs resulting from analyses of ITS1-5.8S-ITS2 sequences of *Pestalotiopsis* spp. –In L 2316.49095. Bootstrap values >50% are indicated above branches. In boldface is the isolate DMC 698a from seeds of *Diospyros crassiflora*. Tree was rooted to *Xylaria* sp.

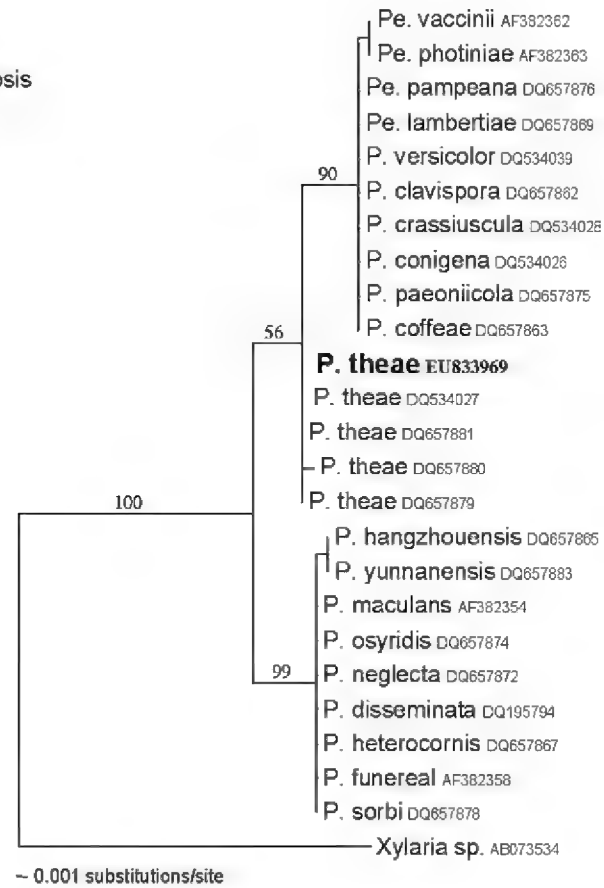
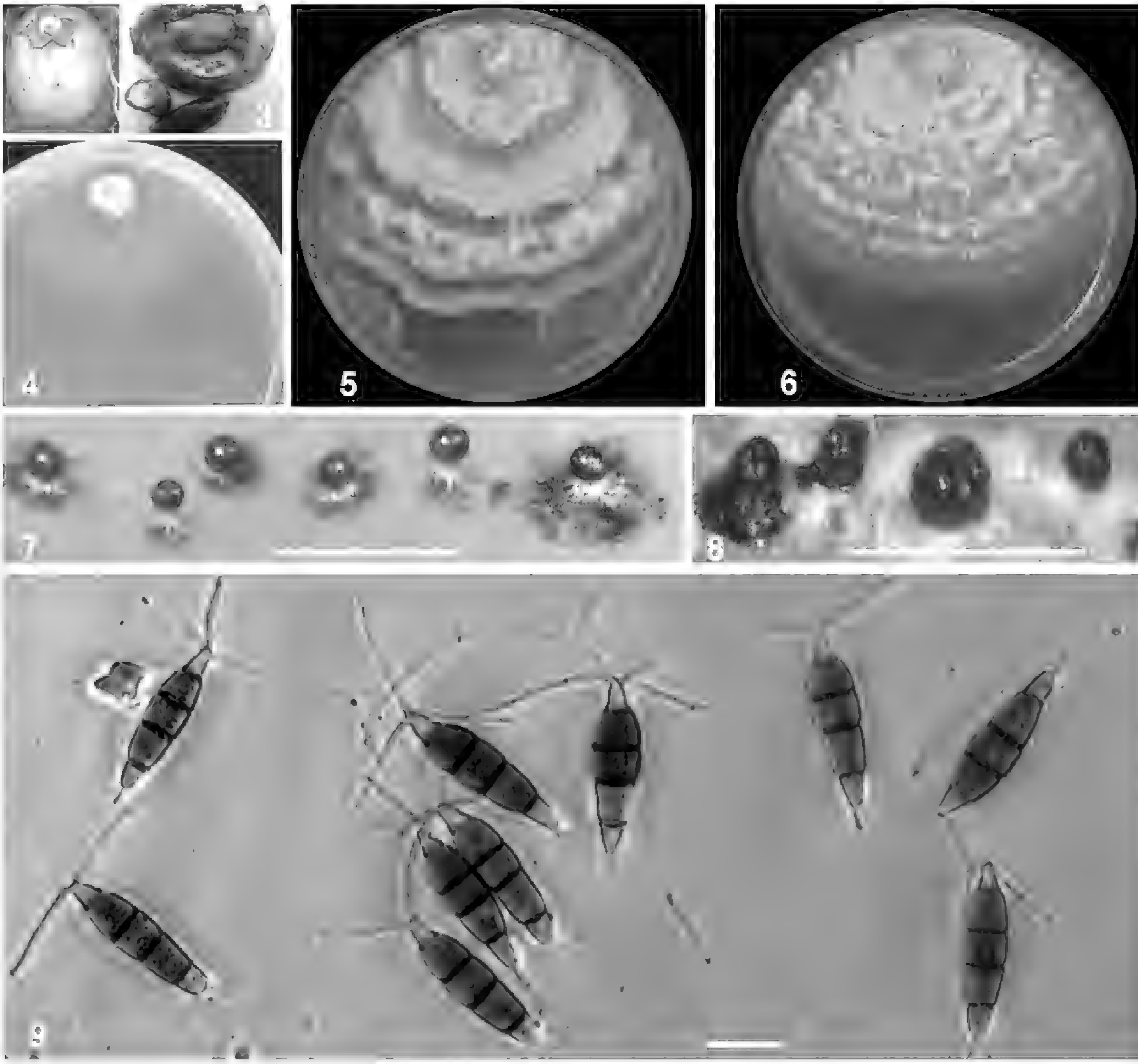


FIGURE 2. Phylogram of a single MLT resulting from analyses of nuc-LSU rDNA sequences of *Pestalotiopsis* and *Pestalotia* spp. –In L 1532.28485. Bootstrap values >50% are indicated above branches. In boldface is the isolate DMC 698a from seeds of *Diospyros crassiflora*. Tree was rooted to *Xylaria* sp.

the nuc-LSU had 100% similarity with *P. theae* strains PSHI2001path099, PSHI2004Endo46, and PSHI2001path205. Both ITS and nuc-LSU sequences of DMC 698a had 0–2% pair base differences with *P. theae* sequences from GenBank. The ITS dataset had 22 OTUs and included 520 characters after exclusion of ambiguous regions. The ITS1 regions were more ambiguously aligned, and had numerous indels than the ITS2 regions. The nuc-LSU dataset of 25 OTUs had 843 characters easily aligned, with a single indel at position 665. MrModeltest 2.2 suggested (HKY+I+G) and (GTR+I) as best-fit models for ITS and nuc-LSU datasets respectively. ML analyses of ITS dataset resulted in 12 most parsimonious likelihood trees (MLTs) of –In L 2316.49095. The best tree determined by K-H and S-H tests ($p < 0.05$) is presented (FIG. 1). ML analyses of LSU dataset resulted in a single MLT of –In L 1532.28485 (FIG. 2). Analyses of both datasets yielded well-resolved topologies delimiting a *P. theae* group, in which nested the isolate DMC 698a from seeds of *D. crassiflora*.



FIGURES 3-9. FIG. 3. Fruits and seeds of *Diospyros crassiflora*. FIGS. 4-6. Colonies of *Pestalotiopsis theae*. 4. On SNA after 3 d. 5. On MYP at 25 °C with 12 hours cool, white, fluorescent light and 12 hours of darkness after 10 d. 6. On MYP in light at room temperature (20 °C) after 10 d. FIG. 7. Acervuli on SNA. FIG. 8. Acervuli on MYP. FIG. 9. Conidia. Bar = 1 mm for 7-8, 10 µm for 9.

Cultural and microscopic characteristics

Optimum temperature for growth 25–30°C. Colony radius after 3 d higher on SNA (27 mm) than MYP (25 mm) and growth subsequently slowing on MYP. Colonies grown on MYP growing faster at 25°C with 12 hours cool, white, fluorescent light and 12 hours of darkness than at room temperature (20 °C), white, floccose cottony, dense and thick, forming marked concentric rings with a barraging aspect, sometimes granulose on old rings due to highly intricate to aggregated hyphae, ultimate margin weakly fibrillose (Figs. 5–6), filling the Petri plate (85 mm) within 10–11 d, production of black (5E4) acervular conidiomata beginning by development of grayish white bands on colony ridges after 14 d, acervuli maturing within 4 d. Colonies grown on SNA pellicular, loose, producing abundant aerial mycelium (FIG. 4), not concentric,

later forming slender mycelial strands, filling the Petri plate (85 mm) within 9 d, acervular conidiomata formed earlier, after 7 d, and rather dispersed on a single, vague pseudoring, without grayish bands.

Acervuli on SNA (Fig. 7) isolate, very scattered, dark brown (6F8) to black (5E4-16G2), slimy and shiny, ampulliform, stipitate on the felted mycelium mixed with crystal-like elements, 200–250 μm in diameter and up to 350 μm high. On MYP, acervuli enfolded with water drops and mycelium until maturity, isolated to mostly concrete, larger, up to 350 μm in diameter. Conidia 23–31 × 5–7 μm, mean 25 × 6 μm, long fusiform, straight or rarely curved, five-celled (Fig. 9), not constricted, including three yellowish brown (5E8- 5D4) to dark brown (6F6) concolorous median cells, with dark bands at the septa. Median cells from the apex 5–7 × 5.5–6 μm, 5–7 × 6 μm, 5–8 × 5.5–6.5 μm respectively. Apical and basal cells hyaline, yellowish (2A2) to olivaceous (3F3). Apical cell conical, 3–5 × 3 μm and basal cell 4–5 × 2.5–3 μm. Appendages appearing at the apex and base, apical appendages 2–3, commonly 3 and rarely 4, 25–40 μm long with spheroidal tip, basal appendage 3–5 μm long.

Identification and ecology

Analyses of ITS and nuc-LSU rDNA sequences supported the placement in *Pestalotiopsis* of the strain DMC 698a isolated from seeds of *D. crassiflora*, as well as its assignment to *P. theae*. Species of *Pestalotiopsis* are usually differentiated on the basis of conidia characteristics such as size, septation, pigmentation, presence or absence and number of appendages (Nag Raj 1993). Conidial characteristics recorded for the strain DMC 698a covered the range for *P. theae*. For instance, the 5-celled conidia of the strain DMC 698a have three intermediate brown or yellowish brown concolorous cells, commonly 3 apical appendages knobbed at the extremities, the features segregating *P. theae* from the closely related species *P. fici* Steyaert, *P. annulata* (Berk. & M.A. Curtis) Steyaert and *P. jesteri* Strobel et al. (Guba 1961, Strobel et al. 2000).

Like other allied species, *P. theae* is not host-specific (Jeewon et al. 2004, Hawksworth 2005, Tejesvi et al 2007, Wei et al 2007) and has been isolated from a number of unrelated hosts. It is commonly a pathogen, known as causal agent of gray blight disease on leaves of *Camellia sinensis* (L.) Kuntze (Chakraborty et al. 1994, Mordue & Holliday 1971, Koh et al. 2001), and causes also leaf necrosis in many tropical fruit and crop plants, e.g. *Cocos nucifera* L., *Diospyros kaki* L.f., *Elaeis guineensis* Jacq., *Mangifera indica* L., *Psidium guajava* L., *Theobroma cacao* L. Nevertheless, *P. theae* is not consistently pathogenic. It has also been isolated from healthy cambium of *Cinnamomum iners* Blume (Woprapong et al. 2003), thus as endophyte. The behaviour of *P. theae* against its host may vary upon environmental conditions, therefore a given strain of *P. theae* can be pathogenic or endophytic on different hosts. Support to this allegation was

provided by ITS analyses in which both pathogenic and endophytic strains of *P. theae* clustered in one clade (Wei et al. 2007). *Pestalotiopsis* species yet isolated from *Diospyros* L. are usually pathogens. Mostly leaves are attacked, like *P. versicolor* (Speg.) Steyaert reported from Madhya Pradesh, India, to cause foliage disease of *D. melanoxylon* Roxb. (Harsh et al. 1987), and similarly, *P. theae* reported as pathogenic fungus of leaf blight in sweet persimmon (*D. kaki*) in Spain (Tuset 1999).

Pestalotiopsis generally colonizes leaf, twig and bark tissue of the host plants. Only a few species have been yet isolated from fruits, viz. *P. heterocornis* (Guba) Y.X. Chen and *P. zonata* (Ellis & Everh.) G.C. Zhao & N. Li from *Podocarpus macrophyllus* (Thunb.) Sweet (Liu et al. 2007, Wei et al. 2007), and *Pestalotiopsis psidii* (Pat.) Mordue responsible for scabby fruit canker of *Psidium guajava* (Keith et al. 2006). In this study *P. theae* (strain DMC 698a) was isolated for the first time from fruits of *D. crassiflora*. Moreover, *P. theae* was isolated for the first time from seeds. This finding gave evidence that this fungus may also be seminicolous. *P. theae* co-occurred on seeds of *D. crassiflora* with an unspecified *Penicillium* and the common seminicolous fungus *Penicilliopsis clavariiformis*. For *Penicilliopsis clavariiformis*, it was stipulated that it infects the seeds while they are still on the plant (Samson & Seifert 1985), this is presumably also valid for *P. theae*. On green unripe as well as on yellow ripe fruits of *D. crassiflora*, neither spots nor corky lesions indicating disease symptoms were observed.

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Micromycetes on *Austrocedrus chilensis*. First record of *Rebentischia* from Argentina

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Abstract — *Rebentischia massalongii* was collected growing on twigs from *Austrocedrus chilensis.* So far known only from the temperate zone of Europe and North America, this species is reported for the first time from Argentina and the Southern Hemisphere. The type specimen of *R. costi,* a species described from Brazil, was re-examined and is here considered an authentic species. A key to the accepted species of *Rebentischia* is provided.

Key words — ascomycetes, *Cupressaceae*, Patagonian forests, *Tubeufiaceae*

Introduction

Austrocedrus chilensis (D. Don.) Pic. Serm. & Bizarri, is an endemic *Cupressaceae* from southern Argentina and Chile. This conifer is widely distributed in the andinopatagonian forests, where it forms pure and mixed stands with *Nothofagus* spp. This tree is highly appreciated for its beauty and the qualities of its wood (Greslebin et al. 2005).

Few ascomycetes have been recorded on *A. chilensis* (Table 1). During our survey of microfungi on this host, we found *Rebentischia massalongii.* This species was known only from the temperate zone of Europe and North America and is here reported from Argentina and the Southern Hemisphere for the first time.

Rebentischia P. Karst. belongs in the *Tubeufiaceae* M.E. Barr. This family of bitunicate ascomycetes was created by Barr (1979) and it is considered a monophyletic clade within the *Pleosporales* (Kodsueb et al. 2006.). The *Tubeufiaceae* is rich in genera and species (see Rossman 1987), but it is still little known (Tsui et al. 2006). Most members are tropical but a few, like *Rebentischia*, appear also in temperate zones.

Barr (1980) revised *Rebentischia* and accepted two species: *R. massalongii* (= *R. pomiformis,* the generic type), which grows on branches and trunks of various woody plants, and *R. unicaudata* (Berk. & Broome) Sacc., which

appears on stems of shrubs and vines. Ahn & Shearer (1999) have since added a third species from *Abies*, *R. abietis* (Fautrey) Ahn & Shearer.

The only species of *Rebentischia* known for the Southern Hemisphere was one described from Brazil, *R. costi,* which Barr (1980) did not study.

The objectives of this paper are to expand the distribution of *Rebentischia* and to give a taxonomic opinion on *R. costi*, reexamining the type material for this purpose. We consider *R. costi* an authentic, separate species and provide a key to the now four accepted *Rebentischia* species.

Materials and methods

Twigs and bark samples of *Austrocedrus chilensis* were collected in Parque Nacional Los Alerces (Argentina) in the spring of 2006. Samples were air-dried and are preserved in Bahía Blanca Biología Herbarium (BBB). The URM Herbarium provided type material of *Rebentischia costi*. Herbarium materials were rehydrated in tap water. Sections were hand-made with a razor blade and were mounted in tap water or in 5% KOH with phloxine. All measurements were made in water. Herbarium abbreviations follow Holmgren et al. (1990).

Table 1. List of ascomycetes previously recorded on *Austrocedrus chilensis*

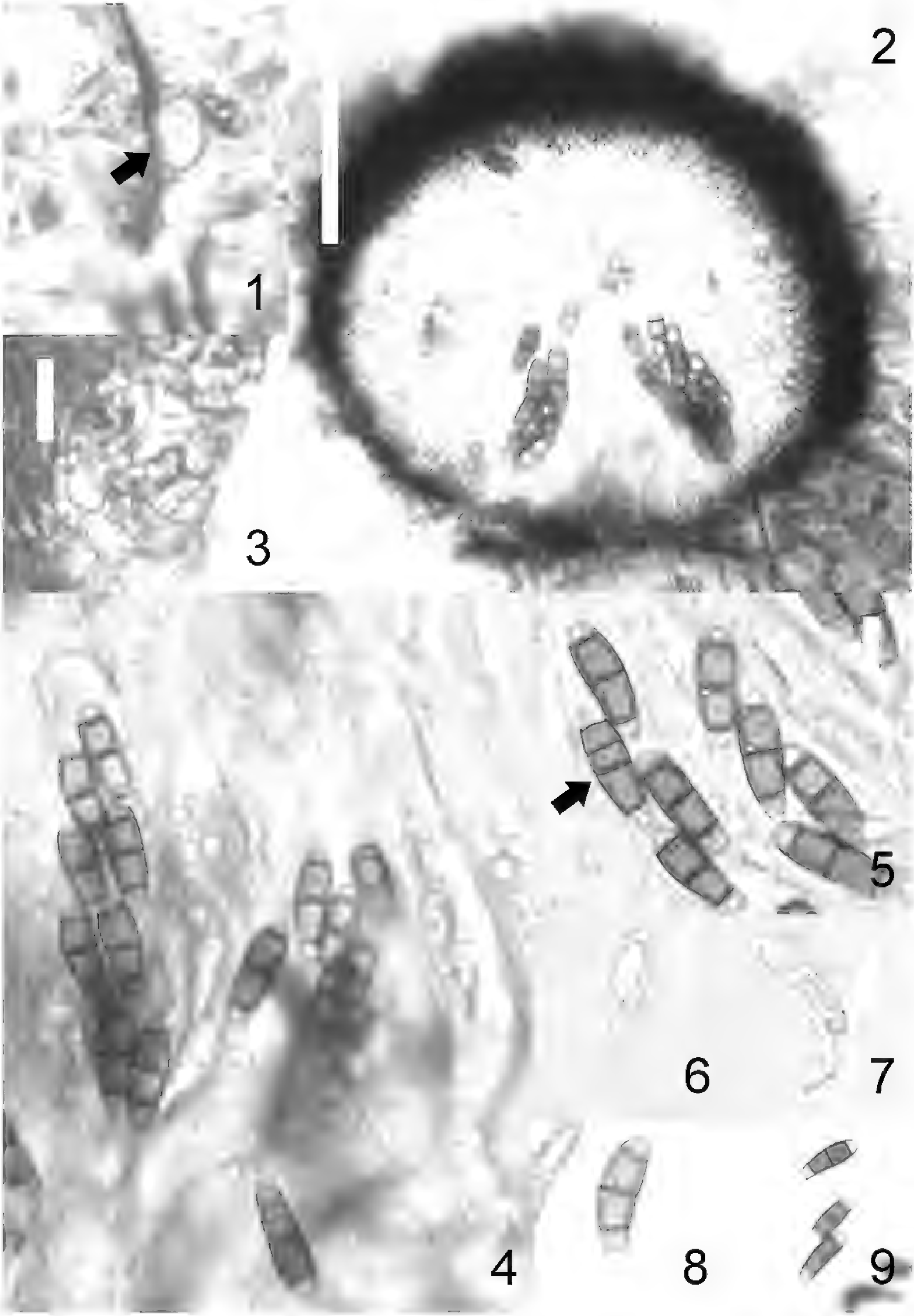
Species	Substrate	Reference
Aspergillus sp.		Minter & Peredo López 2006
Appendiculella austrocedri Butin	leaves	Butin & Peredo 1986
Botryotinia fuckeliana (de Bary) Whetzel	cones	Gamundí et al. 2004
Caliciopsis cochlearis Butin	bark, leaves	Butin & Peredo 1986
Caliciopsis pinea Peck	leaves	Minter & Peredo López 2006
Cladosporium sp.		Minter & Peredo López 2006
Didymella sp.		Minter & Peredo López 2006
Epicoccum purpurascens Ehrenb.		Minter & Peredo López 2006
Hysterium andinense Messuti & Lorenzo	bark	Messuti & Lorenzo 1997
Lophodermium juniperinum (Fr.) De Not.	cones, leaves	Gamundí et al. 2004
Lophodermium sp.	leaves	Gamundí et al. 2004
Mycosphaerella sp.		Gamundí et al. 2004
Morchella sp.		Gamundí et al. 2004
Thyridium sp.		Gamundí et al. 2004

Results and discussion

Rebentischia massalongii (Mont.) Sacc.,
Nuovo Giorn. Bot. Ital. 8: 12. 1876, [as '*massalongi*']. Figures 1–9

≡ *Sphaeria massalongii* Mont., Syll. Gen. Sp. Crypt.: 237. 1856, [as '*massalongi*'].

= *Rebentischia pomiformis* P. Karst., Fungi Fenniae Exsiccati No. 881. 1869.



FIGURES 1–9. *Rebentischia massalongii* (from MVB-RS 205, deposited in BBB). 1. Sectioned ascoma (arrow) immersed on bark of *Austrocedrus chilensis*. 2. Longitudinal section. 3. Peridium. 4–5. Asci. Arrow points to a 5-septate ascospore. 6–7. Immature ascospores. 8–9. Mature ascospores.
Bars: 1 = 250 µm. 2 = 100 µm. 3–8 = 10 µm. 9 = 20 µm.

Ascomata at first immersed, then erumpent, separate, globose, 200–250 × 225–250 µm ($\bar{x}$ = 225 × 237). Peridium soft, fleshy, lateral walls 35–50 µm wide, composed of thick walled, dark brown to vinaceous cells, forming textura angularis, 4–7 × 3–7 µm ($\bar{x}$ = 6.5 × 4.8). Pseudoparaphyses cellular, anastomosing, narrow, 1–2 µm diam., forming an intricate net. Asci bitunicate, claviform 8-spored, 87.5–112.5 × 17.5–30 µm ($\bar{x}$ = 102 × 22). Ascospores narrowly clavate, slightly curved, rounded at the apex, tapering to base, at first hyaline, then dull brown to light vinaceous brown, 4–5-septate, 22.5–31.6 × 7.5–10.2 µm ($\bar{x}$ = 27.4 × 8.7), the primary septum forms near base delimiting a hyaline basal cell, with an elongate, setiform base, 9.2–15.3 µm long. ($\bar{x}$ = 11.9), median cells more pigmented than upper cells, smooth.

Distribution — Europe (Austria, Czech Republic, Finland, France, Germany, Slovak Republic, Sweden, Switzerland); North America (USA); South America (Argentina).

Specimens Examined — **ARGENTINA.** Chubut: Parque Nac. Los Alerces (71°43'51"W 42°46'18"S) — on twigs and bark of *Austrocedrus chilensis,* coll. Bianchinotti & Sánchez *205*, 24.X.2006 (*BBB*).

Comments — Our collection is similar to that described by Barr (1980) as up to 495 µm diam, but the ascomata are smaller. *Rebentischia massalongii* had been recorded only from a few localities of the northeastern United States and various countries of Europe (Farr et al. 2008, Mathiassen & Økland 2007). *Rebentischia massalongii* is an uncommon saprobe (Réblová & Svrček 1997) that is often found growing in association with old cankers. This is the first record on a host in the *Cupressaceae.*

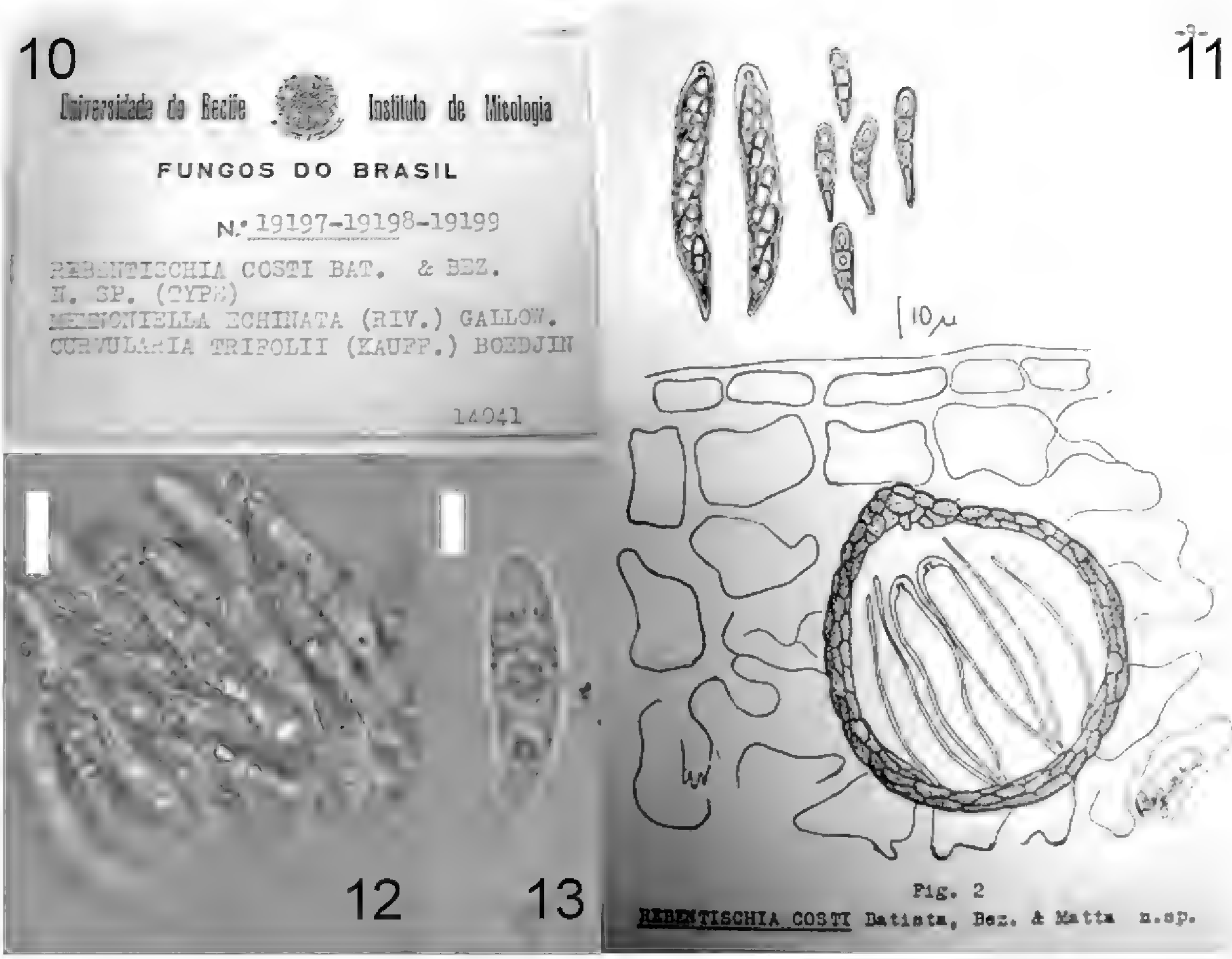
Rebentischia costi Bat., J.L. Bezerra & Matta — Figures 10–13
Publ. Univ. Recife Inst. Micol. 385: 7. 1963.

Description based on Batista & Bezerra (1963) and our own observations: Ascomata epiphyllous, deeply immersed in necrotic spots, sparse, subglobose, 78–115 µm diam., dark brown. Peridium soft, lateral walls up to 10 µm wide, composed of cells disposed in textura angularis, 6.5–8 × 4–6.5 µm. Pseudoparaphyses hyaline, narrow, 1–1.5 µm diam. AscI bitunicate, claviform, 8-spored. Ascospores clavate, at first hyaline then olivaceus, smooth, 3-septate, 20–26 × 5–6 µm, basal cell hyaline ending in a setiform base, up to 6.5 µm long.

Distribution — Brazil.

Specimens examined — **BRAZIL.** Bahia: Ondina – Salvador. Jardim do IBB — on *Costus igneus* leaves, col. EAF da Matta, 16.V.1960 (*URM–CBB 19197*!)

Comments — The type material consists of one leaf with a few ascomata. We have seen only immature ascospores, identical to those described in Batista & Bezerra (1963). These ascospores and the overall description agree in morphology with other species of the genus, so we consider *R. costi* an authentic member of the genus *Rebentischia.*



Figures 10–13. *Rebentischia costi.* 10. Envelope of the holotype. 11. Original illustration given by Batista et al. (1963). 12–13. Ascospores (from URM-CBB 19197). Bars: 12–13= 10 μm.

Rebentischia costi was described from leaves of *Costus igneus* (= *Chamaecostus cuspidatus* (Nees. & Mart.) C.D. Specht & D.W. Stev., fide Specht & Stevenson 2006), a member of the *Costaceae (Zingiberales, Liliopsida)*. It differs from other species in *Rebentischia* by its smaller ascospores. It is also the only species of the genus described from a monocot.

Key to *Rebentischia* species

1a. Ascospores 3-septate, 20–26 × 5–6 μm. Basal cell up to 6.5 μm long.
On leaves of *Chamaecostus cuspidatus* (*Costaceae, Liliopsida*)........... *R. costi*

1b. Ascospores 4–5-septate 2

2a. Basal cell short, up to 4 μm long. Ascospores 4-septate, 23–25 × 8–10 μm.
On *Abies excelsa* (*Pinaceae*).. *R. abietis*

2b. Basal cell longer.. 3

3a. Basal cell up to 15 μm long. Ascospores 4-septate, 17–30 × 4–7.5 μm.
On stems of shrubs and vines .... *R. unicaudata*

3b. Basal cell up to 24 μm long. Ascospores 4–5-septate, 22–40 × 6–10.5 μm.
On woody branches or trunks .... *R. massalongii*

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Leonor Costa Maia and Tatiana Gibertoni from URM Herbarium are warmly thanked for their help. The Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET: PIP 5660) and the Universidad Nacional del Sur (UNS: PGI) are thanked for financial support. We thank Amy Rossman and Julia Checa for acting as pre-submission reviewers and for their helpful comments.

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Three new species of *Lachnum* (*Hyaloscyphaceae, Helotiales*) from Korea

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Abstract — Some interesting hyaloscyphaceous discomycetes were encountered during our mycofloristic investigation of Korea. Among them three foliicolous species of *Lachnum* are described as new taxa. *Lachnum rachidicola* was found on decaying rachis of compound leaves of *Juglans mandshurica. Lachnum hongcheonense* and *L. linderae* were collected on rotting leaves of *Quercus* and *Lindera*, respectively.

Key words — *Ascomycetes*, leaf-inhabiting fungi, taxonomy

Introduction

In continuation of the previous study (Raitviir & Shin 2003) the authors conducted a careful examination of some discomycetous fungi collected from Korea, of which three foliicolous *Lachnum* species turned out to represent new taxa. Their descriptions and illustrations are given.

Materials and methods

The dry materials were rehydrated in 3% aqueous KOH. Melzer's reagent (MLZ) and Lugol's solution (IKI) were used for histochemical reactions. An Olympus BX50 microscope equipped with a drawing tube was used. Measurements of ascospore are shown by the averages ± standard deviations as well as maxima and minima in parentheses. Line drawings and measurements were made in KOH and cotton-blue (CB) unless otherwise stated. The stereomicroscopic photographs were taken by an Olympus SZ40 with digital camera (PixeLINK

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PL-A642). All specimens studied are housed in the Korea University herbarium, KUS, and isotypes of new taxa are deposited in the herbarium of the Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, TAA.

List of new species

Lachnum rachidicola J.G. Han, Raitv. & H.D. Shin, **sp. nov.** FIG. 1

MycoBank MB512729

Apothecia gregaria, longe stipitata, primo subglobosa, dein cupulata usque ad applanato-cupulata, 0.5–2 mm diametro, disco albido vel pallide cremeo, sicca pallide brunneo, receptaculo niveo, vulnerato erubescente, sicca cremeo vel pallide brunneo, dense longipiloso. Excipulum ectale ex textura prismatica compositur, cellulis hyalinis, tenuiter tunicatis, 8–20 × 5–9 µm. Pili cylindracei, apicibus subclavatis, 2–3(–4)-septati, tenuiter hyalinotunicati, verruculati, 25–46 × 2–3 µm. Asci non uncinati, cylindraceo-clavati, octospori, 29–41 × 3.5–4.5 µm, poro MLZ+. Sporae uniseriatae vel irregulariter biseriatae, hyalinae, cylindraceo-clavatae, interdum anguste clavato-ellipsoideae vel clavato-fusoideae, rectae vel minute curvatae, aseptatae, non guttulatae, rariter minute biguttulatae, (5–)5.2–6.4(–7) × (1–)1.2–1.5(–1.6) µm. Paraphyses anguste lanceolatae vel lanceolatae, ascos 5–15 µm superantes, basi 1–2-septate, 2.5–4 µm in diametro.

Species foliicola ascis non uncinatis e apotheciis erubescentis distincta.

Type – On rachis of compound leaves of *Juglans mandshurica* Maxim., Korea National Arboretum, Pocheon, Korea, 37°41'42"N 127°9'47"E, alt. 40 m, 8.V.2002, H.D. Shin (**holotype** *KUS-F50489*, isotype *TAA-182258*).

Apothecia gregarious, seated on a long, well-developed, cylindrical stipe. Receptacle at first almost globose, then becoming cupulate to shallow-cupulate, pure white when fresh, slightly reddening if wounded, cream-colored to pale yellowish or pale brownish when dry, externally densely covered with white hairs. Disc 0.5–2 mm in diameter, white to pale cream-colored when fresh, brownish to pale brown when dry. Stipe up to 3 mm long, concolorous to the receptacle. Hairs cylindric with slightly clavate apex, hyaline, 2–3(–4)-septate, thin-walled, finely warty, not bearing crystals, 25–46 × 2–3 µm, apically swollen up to 4 µm wide. Ectal excipulum hyaline, composed of textura porrecta in the stipe and textura prismatica in the flanks of the cup, cells thin-walled of variable size, 8–20 × 5–9 µm. In old darkened apothecia some brownish amorphous matter is present in intercellular spaces. Asci arising from simple septa, cylindric-clavate, 8-spored, 29–41 × 3.5–4.5 µm, apical pore blue in MLZ. Ascospores uniseriate or irregularly biseriate, clavate-cylindric, sometimes narrowly clavate-ellipsoid to clavate-fusoid, straight to slightly curved, hyaline, aseptate, without inclusions, rarely with bipolar guttules, (5–)5.2–6.4(–7) × (1–)1.2–1.5(–1.6) µm, avg. 5.8 × 1.4 µm (n = 40). Paraphyses narrowly lanceolate to lanceolate, 1(–2)-septate at the base, exceeding the asci by 5–15 µm, 2.5–4 µm wide at the broadest parts.

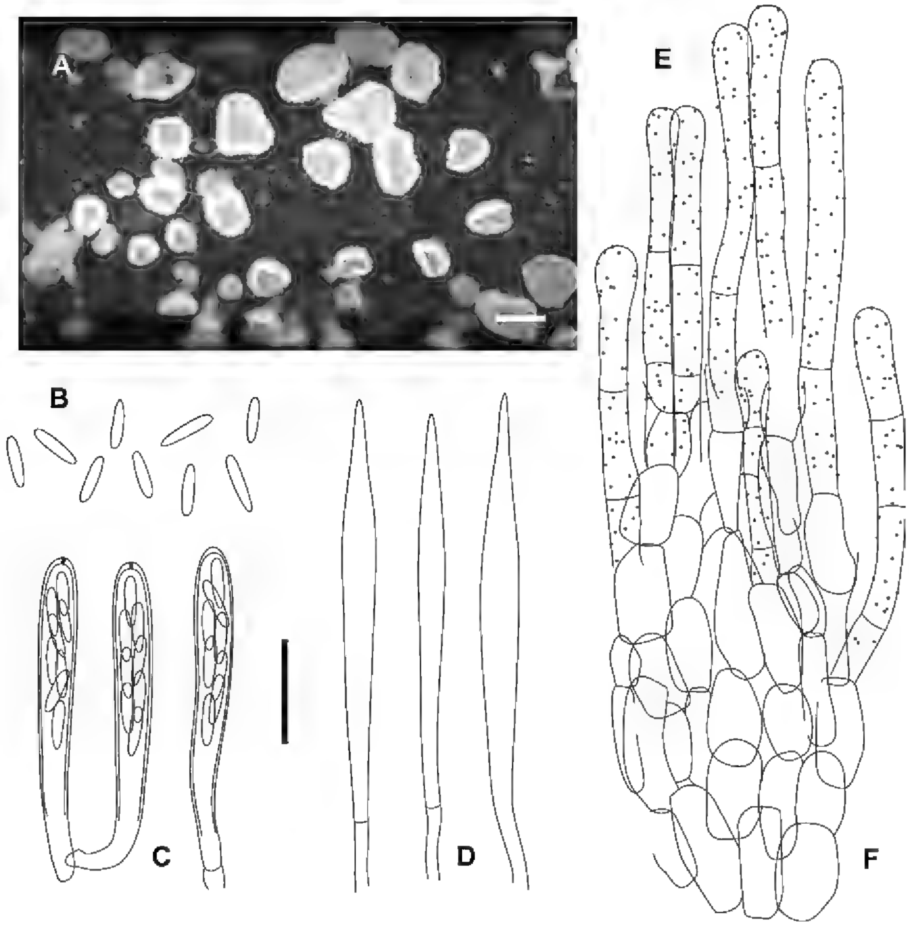

Figure 1. *Lachnum rachidicola* (holotype KUS-F50489).
A: apothecia; B: ascospores; C: asci; D: paraphyses; E: hairs; F: ectal excipulum.
White bar for A = 1 mm, black bar for B–F = 10 µm.

Additional specimens examined – KOREA: Hoengseong, Hoengseong recreation forest, 37°32'13"N 128°7'9"E, alt. 300 m, 22.VI.2006, J.G. Han & H.D. Shin (*KUS-F51117*); Hongcheon, Sambong recreation forest, 37°51'58"N 128°27'57"E, alt. 730 m, 26.VI.2008, J.G. Han & H.D. Shin (*KUS-F52142*); Pyeongchang, Mt. Doota recreation forest, 37°34'33"N 128°34'43"E, alt. 970 m, 17.VII.2008, J.G. Han & H.D. Shin (*KUS-F52196*).

Notes – It seems to be a vernal to early summer species growing on decaying rachis of pinnately compound leaves of *Juglans mandshurica*. It differs from all other species growing on fallen leaves and forest debris in absence of croziers and reddening apothecia.

Lachnum hongcheonense J.G. Han, Raitv. & H.D. Shin, **sp. nov.** Fig. 2

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Apothecia gregaria usque ad dispersa, longe stipitata, primo subglobosa, dein applanato-cupulata, 0.5–1 mm diametro, disco pallide luteo vel cremeo, receptaculo niveo, dense longipiloso. Excipulum ectale ex textura prismatica compositur, cellulis hyalinis, tenuiter tunicatis, 10–16 × 6–12 µm. Pili cylindracei usque ad cylindraceo-clavati, 2–4(–5)-septati, tenuiter hyalinotunicati, verruculati, usque ad 80 × 2.5–3 µm, apicibus capitatis usque ad 6 µm latis. Asci non uncinati, cylindraceo-clavati, octospori, 36–48 × 3–4 µm, poro MLZ+. Sporae biseriatae, hyalinae, anguste cylindraceo-fusoideae, interdum anguste clavato-

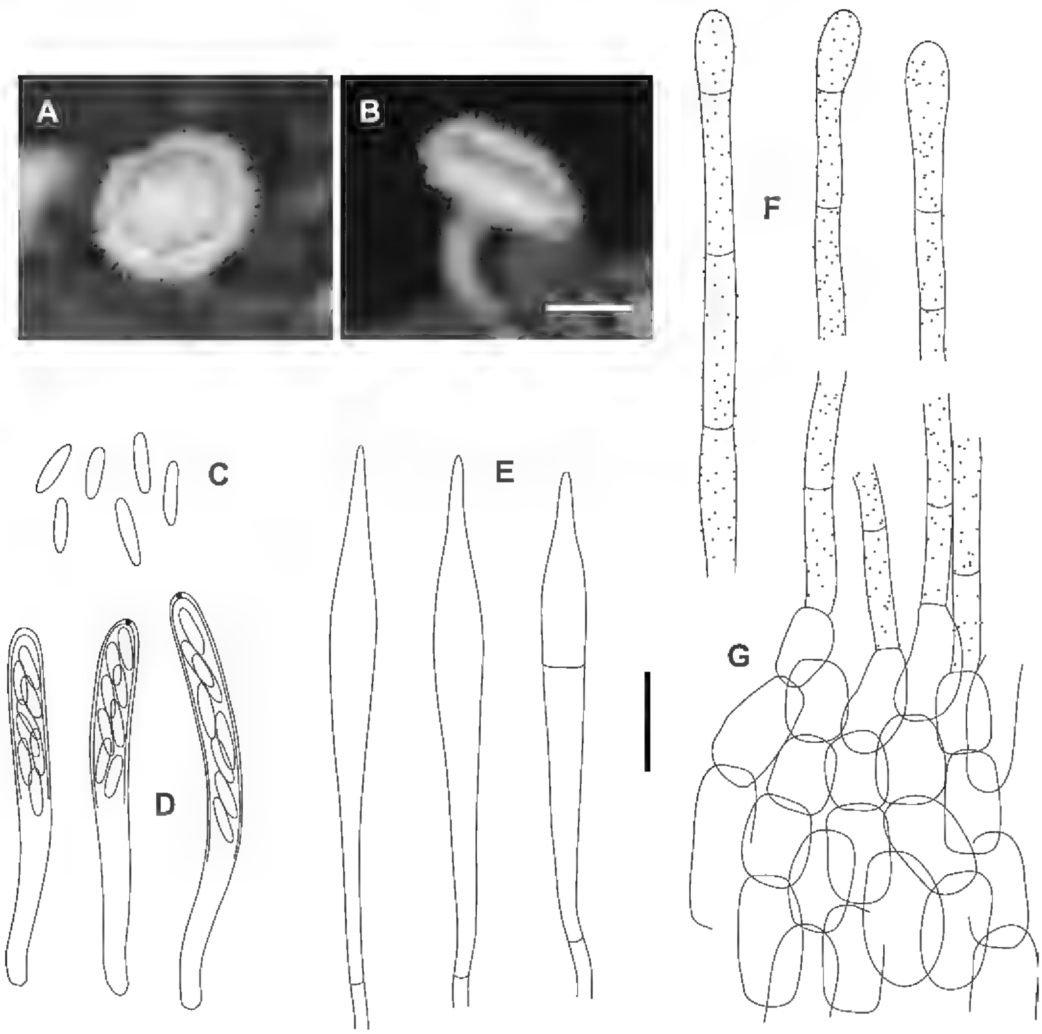

Figure 2. *Lachnum hongcheonense* (holotype KUS-F50509).
A, B: apothecia; C: ascospores; D: asci; E: paraphyses; F: hairs; G: ectal excipulum.
White bar for A and B = 0.5 mm, black bar for C–G = 10 µm.

fusoideae, rectae vel minute curvatae, aseptatae, non guttulatae, (5.5–)5.8–7.0(–7.7) × (1.2–)1.3–1.6(–1.7) µm. Paraphyses lanceolatae, ascos 20–35 µm superantes, 4–6 µm in diametro.

In foliis putridis quercinis crescit. A Lachno charretii e Lachno alnifolio ascis non uncinatis et pilis capitatis differt.

Type – On damp rotting leaves of *Quercus* sp., Experimental Forest of Kangwon National University, Hongcheon, Korea, 37°44'23"N 127°49'54"E, alt. 220 m, 10.V.2002, J.G. Han & H.D. Shin (holotype *KUS-F50509*, isotype *TAA-182261*).

Apothecia superficial, gregarious to scattered, seated on a well-developed, cylindrical stipe. Receptacle at first almost globose, then becoming shallow-cupulate, pure white when fresh and dry, externally densely covered with whitish hairs. Disc 0.5–1 mm in diameter, flat to slightly concave, pale yellowish or cream-colored when fresh and dry. Stipe up to 1.5 mm long, concolorous with the receptacle. Hairs cylindric to cylindric-clavate, hyaline, 2–4(–5)-septate, thin-walled, finely warty, not bearing crystals, up to 80 µm long, 2.5–3 µm wide, apically capitate, swollen up to 6 µm wide. Ectal excipulum composed of textura prismatica, cells hyaline, thin-walled, comparatively big

and wide, 10–16 × 6–12 µm at the flanks of the cup, becoming smaller and narrower toward the margin. Asci arising from simple septa, cylindric-clavate, 8-spored, 36–48 × 3–4 µm, apical pore blue in MLZ. Ascospores biseriate, occupying the upper half of the ascus, narrowly cylindric-fusoid, sometimes narrowly clavate-fusoid, straight to slightly curved, hyaline, aseptate, without inclusions, (5.5–)5.8–7.0(–7.7) × (1.2–)1.3–1.6(–1.7) µm, avg. 6.4 × 1.5 µm (n = 40). Paraphyses lanceolate, containing small refractive globules, exceeding the asci by 20–35 µm, 4–6 µm wide at the broadest parts.

Notes – This species of *Lachnum* on fallen leaves is similar to *Lachnum charretii* Raitv. & Guy Garcia and *L. alnifolium* (Raitv.) Raitv. It differs from both of them in the absence of crozier at the ascus base and capitate hairs, and from the first one also in yellowish disc (Raitviir 1986, Raitviir & Garcia 2000). Its paraphyses are relatively thicker than those of other members of *Lachnum*.

Lachnum linderae J.G. Han, Raitv. & H.D. Shin, **sp. nov.** Fig. 3

MycoBank MB512731

Apothecia dispersa, breviter stipitata, primo subglobosa, dein applanato-cupulata, 1 mm diametro, disco pallide luteo vel cremeo, sicca pallide brunneo, receptaculo albido, dense longipiloso. Excipulum ectale ex textura prismatica compositur, cellulis hyalinis, tenuiter tunicatis, 10–16 × 5–10 µm. Pili cylindracei, 2–3-septati, tenuiter hyalinotunicati, verruculati, usque ad 83 × 3 µm. Asci uncinati, cylindraceo-clavati, octospori, 30–46 × 3–4.5 µm, poro MLZ+. Sporae biseriatae, hyalinae, anguste cylindraceo-fusoideae, interdum anguste clavato-fusoideae, rectae vel minute curvatae, 0–1-septate, non guttulatae, (6–)6.5–8.1(–9) × (1.4–)1.5–1.9(–2) µm. Paraphyses lanceolatae, ascos 20–40 µm superantes, 4–8 µm in diametro.

In foliis putridis Linderae obtusilobae et Linderae erythrocarpae crescit. Lachno albidulo similis, sed in sporis brevioribus differt.

Type – On leaves of *Lindera obtusiloba* Blume, Bokwang-ri, Gangneung, Korea, 37°45'38"N 128°47'29"E, alt. 320 m, 1.VII.2002, H.D. Shin (holotype *KUS-F50570*, isotype *TAA-182263*).

Apothecia superficial, scattered, seated on a short, well-developed, cylindrical stipe. Receptacle at first almost globose, then becoming shallow-cupulate, white when fresh and dry, externally densely covered with whitish hairs. Disc up to 1 mm in diameter, flat to slightly concave, pale yellowish to cream-colored when fresh and dry. Stipe up to 1 mm long, concolorous to the receptacle. Hairs cylindric, hyaline, 2–3-septate, thin-walled, finely warty, not bearing crystals, up to 83 µm long, 3 µm wide. Ectal excipulum composed of textura prismatica, cells thin-walled, hyaline, 10–16 × 5–10 µm. Asci arising from croziers, cylindric-clavate, 8-spored, 30–46 × 3–4.5 µm, apical pore blue in MLZ. Ascospores biseriate, narrowly cylindric-fusoid, sometimes narrowly clavate-fusoid, straight to slightly curved, hyaline, 0–1-septate, without inclusions, (6–)6.5–8.1(–9) × (1.4–)1.5–1.9(–2) µm, avg. 7.3 × 1.7 µm (n = 40).

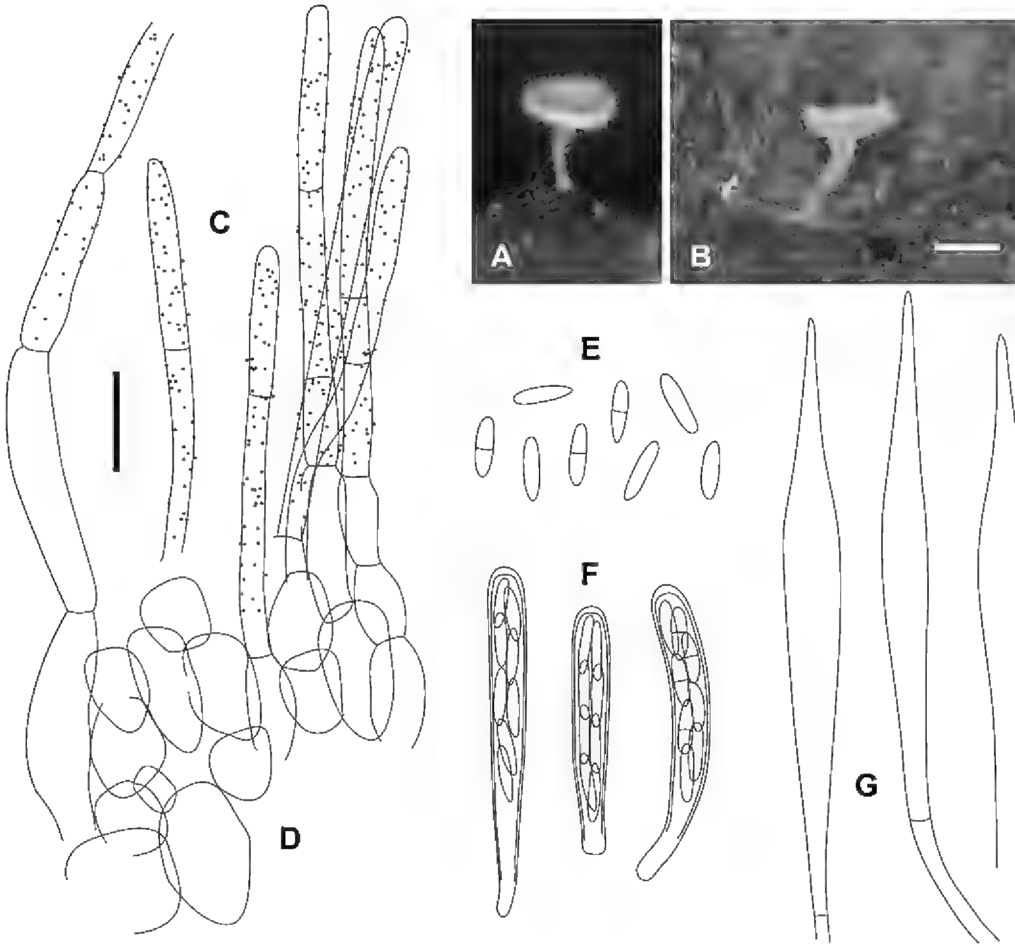

Figure 3. *Lachnum linderae* (holotype KUS-F50570).
A, B: apothecia; C: hairs; D: ectal excipulum; E: ascospores; F: asci; G: paraphyses.
White bar for A and B = 0.5 mm, black bar for C–G = 10 µm.

Paraphyses lanceolate, exceeding the asci by 20–40 µm, 4–8 µm wide at the broadest parts.

Additional specimens examined – On leaves of *Lindera obtusiloba*, KOREA: Muju, Anseong valley in Mt. Deokyu National Park, 35°50'14"N 127°42'15"E, alt. 640 m, 24.IV.2006, J.G. Han & H.D. Shin (*KUS-F50986*); Muju, Gucheondong valley in Mt. Deokyu National Park, 35°53'1"N 127°46'40"E, alt. 680 m, 25.IV.2006, J.G. Han & H.D. Shin (*KUS-F50993*); Dongducheon, Mt. Soyo, 37°56'37"E 127°5'8"E, alt. 320 m, 20.V.2006, J.G. Han & H.D. Shin (*KUS-F51050*); Hongcheon, Hwajeon-ri, 37°36'59"N 127°45'16"E, alt. 220 m, 16.VI.2006, J.G. Han & H.D. Shin (*KUS-F51085*); Gongju, Hashin-ri, 36°22'37"N 127°14'13'E, alt. 170 m, 24.IV.2007, J.G. Han & H.D. Shin (*KUS-F51529*); Wonju, Guryong temple in Mt. Chiak National Park, 37°23'51"N 128°3'2"E, alt. 380 m, 21.V.2007, J.G. Han & H.D. Shin (*KUS- F51569*); Yangpyeong, Experimental Forest of Korea University, 37°24'48"N 127°45'4"E, alt. 130 m, 27.IV.2008, J.G. Han & H.D. Shin (*KUS-F52032*); Hongcheon, Deokchi-ri, 37°41'37"N 127°57'27"E, alt. 210 m, 6.V.2008, J.G. Han & H.D. Shin (*KUS-F52054*); Cheolwon, Mt. Bokju recreation forest, N38°8'32"N 127°28'44"E, alt. 620 m, 16.V.2008, J.G. Han & H.D. Shin (*KUS-F52054*); Pocheon, Gukmangbong recreation forest, 38°1'1"N 127°23'49"E, alt. 430 m, 17.V.2008, J.G. Han & H.D. Shin (*KUS-F52073*); Dongducheon, Mt. Soyo, 37°56'29"N 127°4'9"E, alt. 280 m, 20.V.2008, J.G. Han & H.D. Shin (*KUS-F52077*); Hoengseong,

Heongseong recreation forest, 37°32'9"N 128°7'9"E, alt. 320 m, 20.VI.2008, J.G. Han & H.D. Shin (*KUS-F52120*); Yangyang, Micheongol recreation forest, 37°56'36"N 128°31'14"E, alt. 310 m, 26.VI.2008, J.G. Han & H.D. Shin (*KUS-F52147*). On leaves of *Lindera erythrocarpa* Makino, KOREA: Seogwipo, Seogwipo recreation forest, 33°18'52"N 126°28'24"E, alt. 710 m, 8.V.2006, J.G. Han & H.D. Shin (*KUS-F51020*); Hamyang, Mt. Jiri recreation forest, 35°20'58"N 127°38'38"E, alt. 600 m, 5.V.2008, J.G. Han & H.D. Shin (*KUS-F52047*); Sancheong, Georim valley in Mt. Jiri National Park, 35°17'31"N 127°42'50"E, alt. 890 m, 6.V.2008, J.G. Han & H.D. Shin (*KUS-F52049*); Daejeon, Mt. Manin recreation forest, 36°11'49"N 127°26'49"E, alt. 330 m, 24.V.2008, J.G. Han & H.D. Shin (*KUS-F52089*).

Notes – *Lachnum linderae* can be compared in its short asci with *L. rhytismatis* (W. Phillips) Nannf., but the latter has conspicuous crystal balls on its hairs and strongly clavate spores. *Lachnum alnifolium* is also close to the present species but has longer asci and much shorter paraphyses exceeding the asci by up to 18 µm (Raitviir 1986). There is a pantropical foliicolous species *L. albidulum* (Penz. & Sacc.) M.P. Sharma growing on wide variety of fallen leaves but it is distinguished by its longer spores measuring 10–15 × 1.2–1.7 µm (Haines 1992). This new fungus apparently shows substrate-specificity on leaves of *Lindera* spp.

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Aurosphaeria, a novel coelomycetous genus

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Abstract — An endophytic pycnidial producing fungus was isolated from *Drosera montana*, growing in the Heath River area of the Bolivian Amazon. Based on morphological characteristics of the pycnidium, the nature of the conidiophores and conidial structure as well surprisingly unique DNA sequence data on this fungus, a new genus, *Aurosphaeria*, is described. The nearest genetic neighbor is *Stemphylium* sp. with a query coverage of 87% and a maximum identity of 89%. This fungus is not morphologically related to *Aurosphaeria*. Morphologically, the most similar fungus is *Hapalosphaeria* sp.; however, *Aurosphaeria* deviates from *Hapalosphaeria* by its unique phialidic conidiophores, the presence of decorative hyphal tufts on the pycnidia, and other features that are herein described. Biochemically, *A. flaviradians* is of interest as it produces copious quantities of brefeldin A, a biologically active compound, in liquid culture.

Key words — rDNA, endophyte

Introduction

Endophytes are a potential source of many novel biologically active compounds (Strobel & Daisy 2003). Defined as microorganisms that live in the interstitial spaces of live plant tissues, endophytes live symbiotically with plants and are not generally considered to be parasitic (Bacon & White 2000). Because these organisms (mostly fungi) are positively associated with plants, there is a great opportunity to find and characterize new endophytes with useful,

non-toxic applications (Strobel & Daisy 2003). Searching for these novel and useful endophytes can be accomplished with a relatively high success rate in unique ecosystems such as the Amazonian rainforest, which possesses the greatest plant diversity on earth (Arnold et al 2001 2007; Mittermeier et al 1999). Associated with this enormous diversity of higher plants is also a diversity of microorganisms. In fact, a recent survey of 150 endophytic fungi from the upper Amazon in Peru and Bolivia showed that about 10% of these endophytes contained rDNA sequences that are wildly divergent from the fungi previously documented in GenBank (Smith et al 2008). These biologically and taxonomically unique endophytes are extremely valuable since they often make useful and novel bioactive metabolites (Strobel & Daisy 2003 Tan & Zou 2001). Additionally, the general biology, host specificity, production of secondary products, host-plant interactions, and endophyte-endophyte interactions of endophytes have scarcely been studied in any plant system, and given the potential benefits of endophytes, these areas are well worth studying.

Isolate P404e was recovered from the inner leaf tissues of a specimen of *Drosera montana* growing in a savannah region located in the Heath River country of the Bolivian Amazon. To capture its prey, *D. montana* has developed unique insect-trapping glandular stalks on its leaves. Previous efforts to isolate endophytes from this plant are not known to the authors. Using molecular techniques, this isolate, P404e, was found to be possessing nrITS sequences that were not similar (<89% similarity) to any taxonomically characterized fungus on record in GenBank. In addition, the specific morphological characteristics of the organism did not match those of any previously described fungus with globose pycnidia, septate conidiophores, and aseptate, hyaline, smooth- walled, globose conidiospores. The fungus was initially of interest due to its ability to inhibit the growth of bacterial test organisms including *Escherichia coli*. Later it was discovered to produce the bioactive compound brefeldin A in copious amounts. Morphological and molecular biology studies indicate that P404e possesses other unique features that are described in this report. The name proposed for this novel endophytic fungus is *Aurosphaeria flaviradians.*

Materials and methods

Fungal isolation

Several intact plants of *Drosera montana* A. St.-Hil. were acquired in the Bolivian Amazon during March of 2007. They were collected in a savanna region adjoining the rainforest at 12° 40' 07" S and 68° 41' 58" W and were transported to Yale University for analysis. Several small pieces from the plant stems including the leaves were cut and placed into 70% ethanol for 30 seconds under a laminar flow hood. Sterile tweezers were used to hold the stems separately in the flame to remove excess alcohol. Then the leaves were scored and the epidermal layer removed. Portions of the inner tissues were then placed onto water agar. After two weeks, a number of fungal isolates were obtained from

this plant. One of these cultures (P404e) was the subject of this study as it produced an unusually yellow metabolite and appeared distinct from the other endophytes. It also possessed antibiotic activity when used in a screening test (Castillo et al 2007).

Scanning electron microscopy

Scanning electron microscopy was performed on P404e following procedures described by Castillo et al. (2005). Agar pieces and carnation leaf pieces supporting fungal growth were placed in filter paper packets then placed in 2% gluteraldehyde in a 0.1 M sodium cacodylate buffer (pH 7.2-7.4) with Triton-X 100 (a wetting agent), aspirated for 5 minutes and then left overnight. The following day, samples were washed six times in 15 min washes of water buffer 1:1, followed by a 15 min wash in 10% ethanol, a 15-min wash in 30% ethanol, a 15 min wash in 50% ethanol, five 15-min washes in 70% ethanol, and then finally left overnight or longer in 70% ethanol. The samples were then rinsed six times for 15 min in 95% ethanol then three 15-min washes in 100% ethanol, followed by three 15 min washes in acetone. The microbial material was then critically point dried, gold sputter coated, and images were recorded with an XL30 ESEM FEG in the high vacuum mode using the Everhart-Thornley detector. Conidiospores and pycnidia were measured using Image J software (available online: http://rsb.info.nih.gov/ij/).

Fungal growth and storage

Several methods were used to store the isolated fungus as a pure culture. The fungus was grown on potato dextrose agar (PDA) for two weeks, and then it was cut into small squares which were placed into vials containing 15% glycerol and stored at –70° C. However, the most effective method of storage was on sterile barley seeds that had been colonized by the fungus for at least 10 days and these were air dried and then stored at –70° C. The fungus has been designated as isolate 2349 in the living culture collection of Montana State University.

Fungal DNA isolation and acquisition of ITS- 5.8S rDNA sequence information

P404e was grown on potato dextrose broth for 7 days, after which the mycelium was harvested and the genomic nucleic acid (DNA) extracted using DNeasy Plant and Fungi Mini Kit (Qiagen), according to the manufacturer's directions. The ITS regions of the fungus were amplified using PCR with the universal ITS primers ITS1 (5' TCC GTA GGT GAA CCT GCG G 3') and ITS4 (5' TCC TCC GCT TAT TGA TAT GC 3'). All other procedures were carried out as previously described by Ezra *et al.*, 2004. The DNA was sequenced at the W.M. Keck Facility at Yale University, and the sequences were submitted to GenBank on the NCBI web site: http://www.ncbi.nlm.nih.gov). Sequences obtained in this study were compared to the GenBank database using the BLAST software on the NCBI web site: http://www.ncbi.nlm.nih.gov/BLAST/).

The sequence data of this fungus are deposited in GenBank as EU977279. A phylogenetic tree showing the relationship of P404e to other fungal organisms was constructed (Edgar, 2004; Ronquist and Huelsenbeck, 2003; Smith et al., 2008).

Isolation and characterization of brefeldin A

Brefeldin A, an ER-golgi transport inhibitor (Dinter & Berger 1998), was recovered from a 100 ml, 5-week-old potato dextrose (PD) broth culture of isolate P404e. After

growth of the culture according to these parameters, the resulting broth was filtered through several layers of cheesecloth to remove the fungal mycelia. The filtrate was then extracted with an equal volume of dichloromethane (CH_2Cl_2), after which the solvent was evaporated to dryness. The resulting material was stored in a minimal volume of methanol at 4°C until further analysis was performed. Given that this crude extract showed bioactivity in an immunomodulatory context, silica column chromatography was performed to separate the mixture of compounds present in the crude extract. A fraction eluting with a solvent system of 93:7 v/v of CH_2Cl_2:CH_3OH formed crystals when evaporated to dryness. The crystals were re-dissolved in a minimal volume of CH_2Cl_2 then the solvent was re-evaporated slowly at 4°C to prepare crystals suitable for x-ray crystallography. Once the larger crystals were formed, they were subjected to standard x-ray crystallographic procedures, which unequivocally determined the molecule to be brefeldin A.

Taxonomy

Aurosphaeria Sun J. Lee, Strobel, Eisenman, B. Geary, P.N. Vargas & S.A. Strobel, **gen. nov.**

MycoBank 512382

Aurosphaeria *deviare de* Hapalosphaeria *sollicitus phialidi conidiphoras et habemus ornamenti hyphae indumentum in pycnidia.*

Type species: *Aurosphaeria flaviradians.*

Etymology: The genus name, *Aurosphaeria* is taken from the Latin word *auro,* meaning gold, and *sphaeria,* meaning sphere-like, to describe the golden, nearly spherical pycnidia.

Unique Characteristics: The genus is differentiated from *Hapalosphaeria* in possessing unique phialidic conidiophores, decorative hyphal tufts on the pycnidia, and globose erumpent pycnidia.

Aurosphaeria flaviradians Sun J. Lee, Strobel, Eisenman, B. Geary, P.N. Vargas & S.A. Strobel, **sp. nov.** Figs. 1–3.

MycoBank 512383; GenBank EU977279

Fungus in natura est consociatis cum Drosera montana *Pycnidia aurum, est in 2-7 verticillata, globosae, membrana angosta, cum textura angularis, ornamento indumento pubescentia dematiacea hyphae, et 148± 5μ. Conidiophoras translucida, ramis in apice, formis in celula membrana pycnidial, 8-15 μ longis. Conidiogenous celula enteroblastis, phialidiae, determinativus, translucida, lisa. Conidia globosae, hyalinis, lisa, membrana angosta, egluttulata, 2.5± 0.1 μ.*

Etymology: The organism produces a bright yellow metabolite in culture, and thus from the Latin –*flaviradians* or 'radiating yellow'.

Type: Bolivia, Amazon, Heath River Forest, March 14, 2007, K. Eisenman & P.N. Vargas (MONT 2349, **holotype**).

Living culture collection: isolated from the same *Drosera montana* plant as the dried type collection and maintained in Montana State University mycological culture

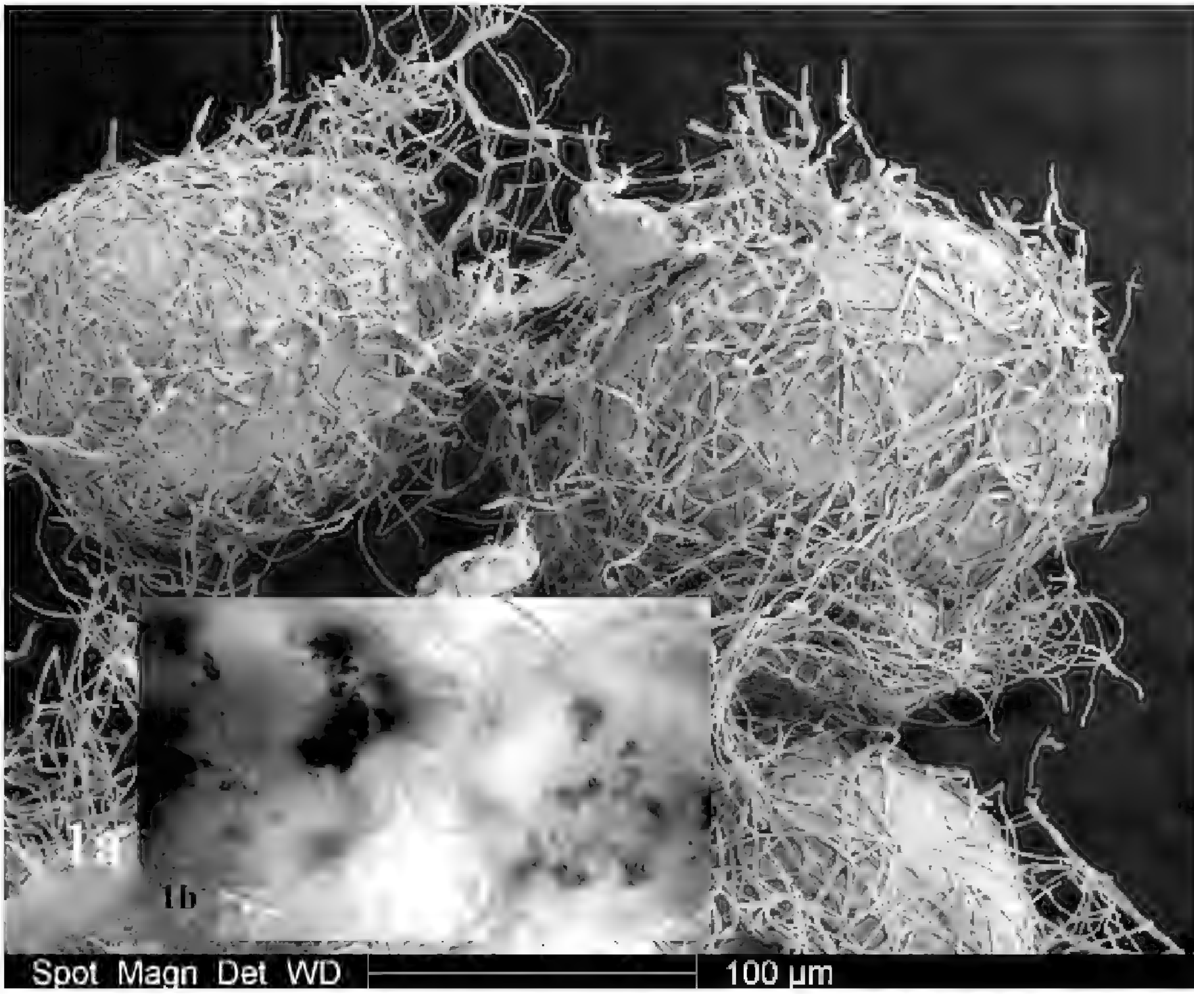

Fig.1a Two globose pycnidia observed by SEM. Tufts of hyphae decorate each pycnidium. These structures possess no ostiole and thus spore release is via some disruptive event leading to cleavage of the pycnidial wall. The bar represents 100µ. Fig 1b (inset). Light microscopy reveals the characteristic dark hyphal tufts that decorate each of two pycnidia. The size of the pycnidia is noted in the legend to Fig 1a.

collection; **Bolivia**, Amazon — Heath River Forest: March 14, 2007, K. Eisenman & P.N. Vargas MONT 2349 (6/21/2008).

Teleomorph: The teleomorph of this fungus is unknown. The molecular data from the 18S rDNA gene sequences of *A. flaviradians* provide no hint as to the fungal family relationship that this organism may possess (Bruns et al., 1991; Reynolds and Taylor 1993; Mitchell et al., 1995; Guarro et al., 1999; Taylor et al., 1999).

Aurosphaeria flaviradians is associated in nature with *Drosera montana.* It was not recovered from other plants growing in the same topographical area. This fungus is characterized by having whitish colonies on PDA (top side) and a yellow undulating grooved mycelia mat on the reverse side. The erumpent pycnidia are golden, usually occurring in clusters of 2 to 7, and are globose with no apparent ostiole. The pycnidia are also thin-walled, made of textura angularis, and are decorated with tufts of dematiaceous hyphae (148 ± 5 µm).

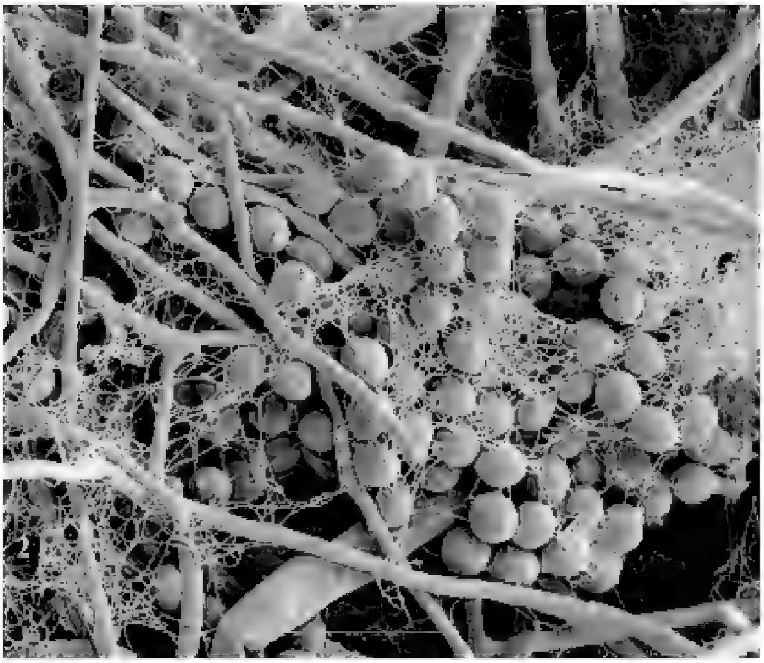
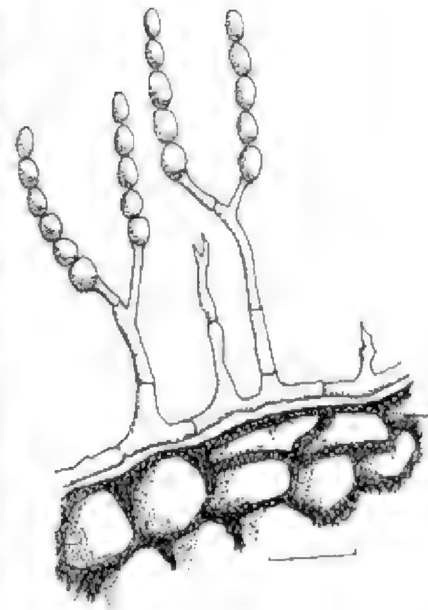

Fig. 2 (left).Masses of conidiospores associated with matrix material as observed by SEM. The bar is equivalent to 10µ. Fig. 3 (right). An artist's rendition of conidiospore production within the pycnidium. The bar is equivalent to 7.5µ.

Thus, this fungus is a coelomycete. Conidiophores, which line the inside pycnidial walls, are hyaline, branched at the tips, and formed from inner cells of the pycnidial wall. They range in length from 8 to 15 µm. The conidiogenous cells are enteroblastic, phialidic, determinate, hyaline, and smooth. Conidia (2.5± 0.1 µm) are globose, hyaline, smooth, thin-walled, eguttulate, and borne in chains (Fig. 2). This fungus produces brefeldin A and related compounds.

Comments on the biology of *Aurosphaeria flaviaradians*

Aurosphaeria flaviradians produces a whitish-tan mycelium on PDA. After a week in culture, numerous erumpent, globose, and golden pycnidia are produced in a concentric fashion on both 1/10 and PDA, resulting in a yellowish-tan, roughened surface almost resembling sand paper. This roughened surface is due to the numerous clumps of protruding pycnidia. The clumps contain 2 to 7 or 8 pycnidia. On the reverse side of the PDA plate, the mycelium is yellow and undulates at the center and periphery of the culture. The pycnidia are superficial on the agar surface and possess no ostiole. The tufts of interwoven dematiaceous hyphae that decorate the surface of each pycnidium are randomly arranged (Fig.1a,b). The pycnidia dehisce to disseminate spores. These conidial characteristics are completely unlike those of the nearest phylogenetic relatives, *Stemphylium* sp., *Berkleasmium* sp. and *Lophiostoma* sp., all of which possess darkened, multi-cellular conidia (Irwin et al. 1986, Moore 1959, Tanaka & Harada 2003). The closest morphological relative of this fungus appears to be *Haplosphaeria deformans*, which *A. flaviradians* resembles in some respects,

but *H. deformans* lacks conidiophores and erumpent pycnidia decorated with hyphal tufts (Fig. 1a, b).

Aurosphaeria flaviradians has only been collected from the Heath River area in Bolivia. It exists as an endophyte in an insectivorous plant, *Drosera montana*. It was not possible to isolate it from any other plant species in proximity to its original host. No symptoms or signs of the fungus were evident on the host supporting it, and its role in the plant is currently unknown. However, given the products that it makes, one may infer that a complex biology governs fungus+plant interactions.

The secondary metabolites of this organism were also studied. After 5 weeks of culture in PD broth, *A. flaviradians* produced a variety of pigmented and non-pigmented compounds, some with distinct odors, which were separated via silica column chromatography. Of these, one compound crystallized and the structure was solved by x-ray crystallography. The findings, which were additionally supported by mass spectrometry data, concluded that the compound was the Golgi-disruptor brefeldin A (Fujiwara et al., 1988). None of the phylogenetic relatives of this fungus mentioned above have been reported to produce brefeldin A.

The role of brefeldin A and its derivatives made by this fungus in the context of host-fungus biology is unknown. However, the discovery of this novel organism nicely illustrates a main tenant of this report—that areas of the world housing vast plant diversity also could possess comparable microbial diversity. Such unusual microbial diversity is likely to lead to products and processes that have implications for a wide variety of biotechnical applications (Strobel & Daisy, 2003 Strobel 2006).

Phylogenetic results

Given the highly conserved nature of fungal rDNA sequences, the ITS (internal transcribed spacer) region of the rDNA is particularly useful in determining both the identity of any given specimen as well as its nearest phylogenetic relatives (Mitchell et al., 1995). Sequences of the P404e rDNA ITS1 and ITS2 regions were compared to the GenBank database using BLAST. The most similar organisms were unnamed and uncultured fungi with query coverage and maximum identity of the top hit being 93% (AY699698.1). Out of the taxonomically characterized organisms, the closest genetic relative was a *Stemphylium* sp. with a query coverage of 87% and a maximum identity of 89% (EU339369.1). In order to view the data in a wider phylogenetic context, a tree was constructed using methods of Smith et al., 2008. Phyutility was initially used to retrieve the top-ranking 100 BLAST sequences; however, this number was then reduced to 40 to remove more distant redundancies (Smith & Dunn, 2008). From the resulting list, sequences from such organisms without

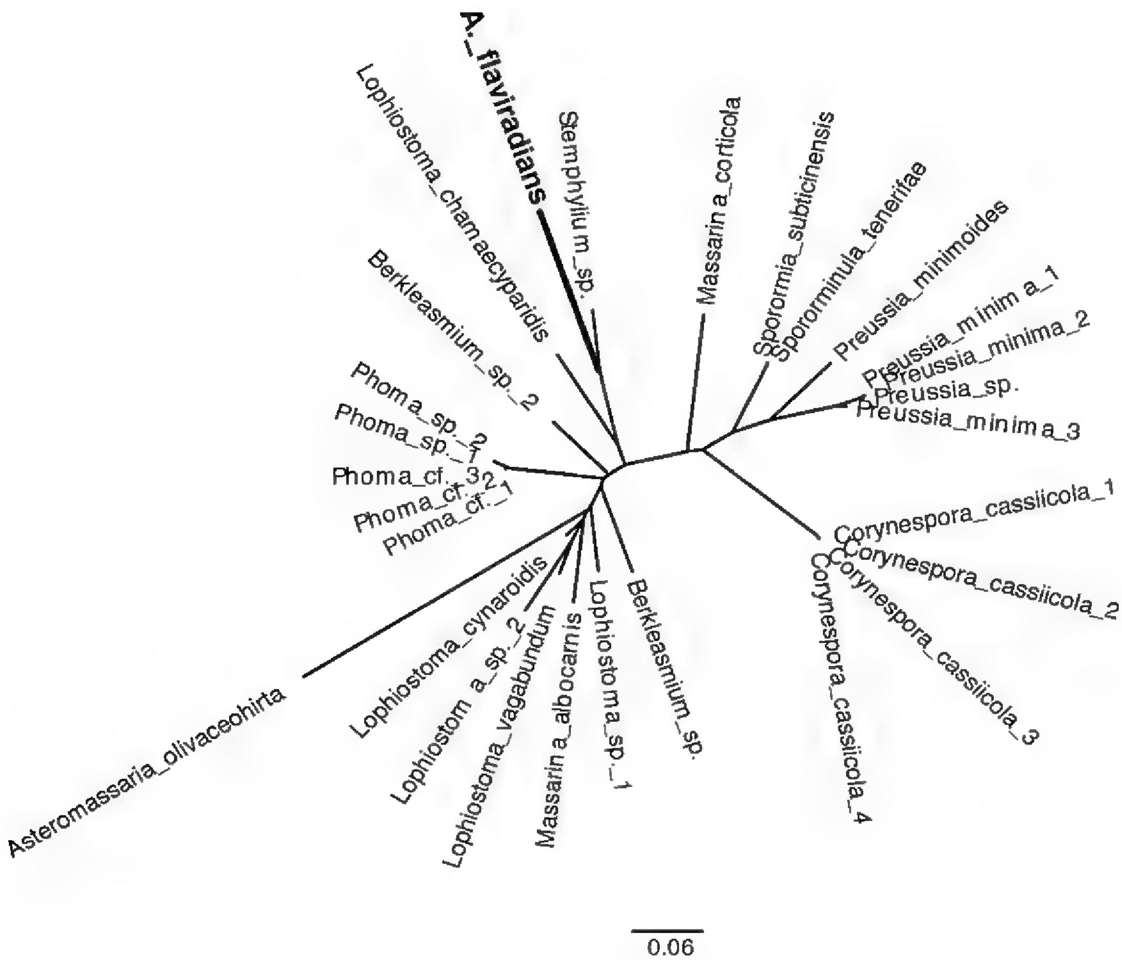

FIG. 4. Unrooted radial tree detailing the phylogenetic location and evolutionary distances of *Aurosphaeria flaviradians* to the 27 most similar ITS sequences in Genbank, omitting such entries as "uncultured fungi". Figtree v1.1.2 was used to visualize the tree.

taxonomic characterization (such as those named "Uncultured fungus" and "Fungal sp.") were excluded, and the resulting list of 27 sequences was then aligned using MUSCLE (Edgar 2004), with sites missing >50% of the data excluded from analysis (Smith et al. 2008). Bayesian analyses were then performed with MrBayes 3.1.2 (Ronquist & Huelsenbeck 2003 Smith et al. 2008). Figtree v1.1.2 was used to visualize the analyzed data in an unrooted radial tree (FIG. 4). The molecular biological analysis supports and confirms the conclusion that *A. flaviradians* is a unique fungus.

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Leucoagaricus lilaceus (*Agaricaceae*), a poorly known Neotropical agaric

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Abstract — The type collection of *Leucoagaricus lilaceus* was studied. This poorly known Neotropical member of *Agaricaceae* is fully described and illustrated for the first time. This species is known only from Brazil and Argentina.

Key words — *Agaricales, Basidiomycota*, biodiversity, taxonomy, Itapuã Park

Introduction

South American agaric species have long been collected and described during mycological investigations by many researchers, including Dennis (1961, 1970), Rick (1937, 1938a, 1938b, 1939, 1961), Singer (1953, 1973, 1989), Singer & Digilio (1952), and Spegazzini (1926). Many of these early species that are known only from their first report were originally documented only by a Latin diagnosis unaccompanied by illustrations. Additional collection aided by re-evaluation of type materials is needed to establish knowledge of the native mycobiota. Much hard taxonomic work is now being conducted in investigating members of the large family *Agaricaceae*, including the species discussed below.

Leucoagaricus lilaceus was described by Singer (Singer & Digilio 1952), who limited his protologue to an elaborate Latin diagnosis that lacked accompanying pictures or plates. During a survey of the mycobiota of Itapuã State Park and sporadic visits to Farroupilha Park in southern Brazil, some collections of this interesting mushroom were gathered and fully illustrated both macro- and microscopically. The present paper offers a detailed description of this poorly known species accompanied by full drawings and photos. It comprises preliminary results of a survey of the *Agaricaceae* found in Itapuã State Park, Rio Grande do Sul State, Brazil.

Materials and methods

All collections were obtained in the state of Rio Grande do Sul, Brazil, from Itapuã State Park (30°20'–30°27' S and 50°50'–51°05' W within the municipality of Viamão; see also Silva et al. 2006) or Farroupilha Park (30°02' S and 51°13' W within the municipality of Porto Alegre). Macroscopic analysis of the basidiomata followed Largent (1977). Color terminology was taken from Kornerup & Wanscher (1978). Microscopic observations were made after drying, with thin sections mounted in 5% KOH and 1% Congo Red solutions (Largent et al. 1986). In the basidiospore descriptions, the abbreviation *Q* denotes the length/width quotient, with Q_{av} denoting the average *Q*. The notation [210,7,7] indicates that measurements were made on 210 spores in seven samples from seven collections. Microscopical observations were made using a LEICA DM LS2 optical microscope; line drawings of all microstructures were rendered using a drawing tube. Specimens were deposited in the herbarium ICN, and material deposited in BAFC and LIL was studied as well.

Results and discussion

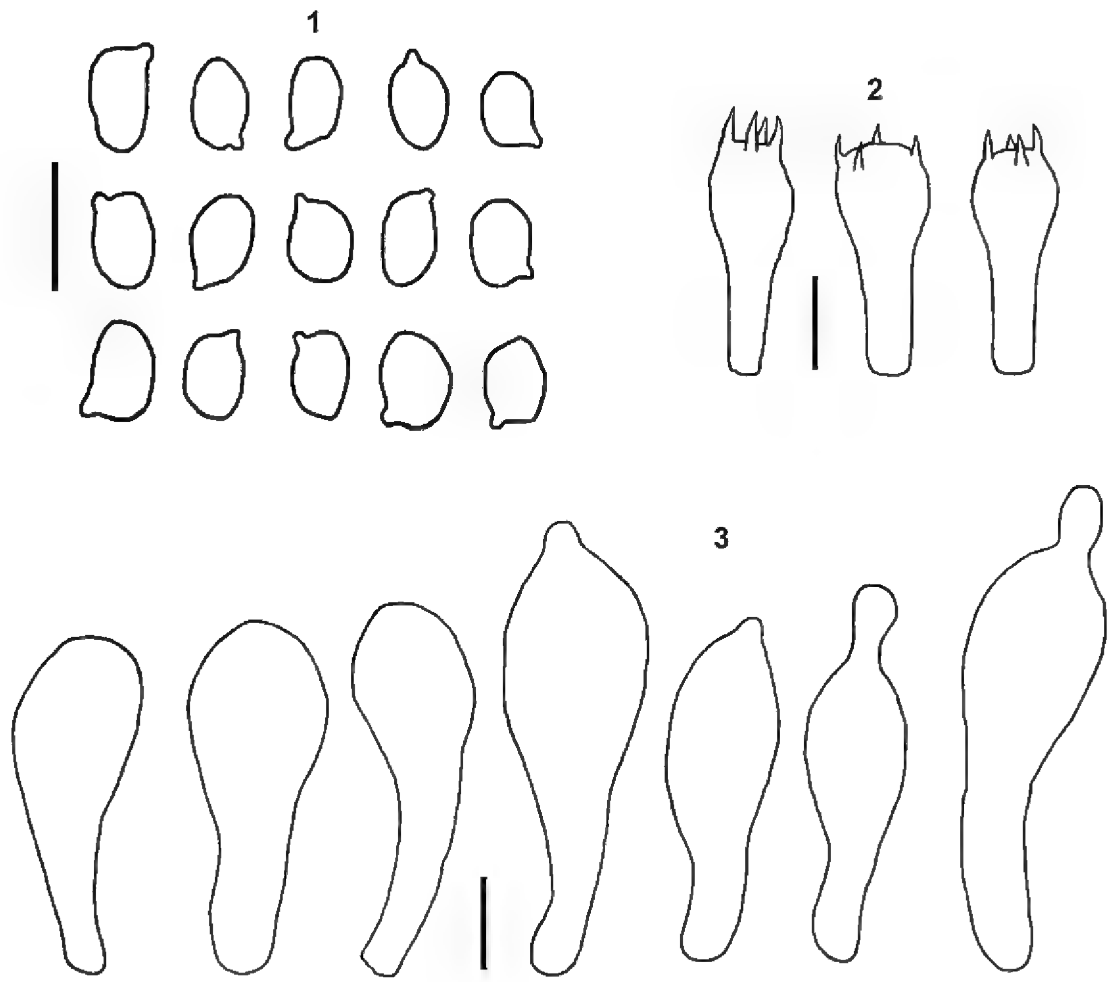
Leucoagaricus lilaceus Singer, Lilloa 25: 274 (1952) '1951'. FIGS. 1–10.

DESCRIPTION OF TYPE COLLECTION (Singer T 396 [LIL])

SINGER & DIGILIO (1952): "*Pileo lilaceo-purpureo, interdum fibrillis pallidis appressis in centro, sed centro plerumque subvelutino ex strato palisadico cuticulae et haud rimoso, marginem versus minute rimuloso et interdum demum rimoso squamoso vel rimoso-granuloso, inter squamulas granulosque albo vel brunneo vel vinaceo, sicco, convexo, dein applanato demum interdum concavo, subumbonato, vel obtuse umbonato, 46-89 mm lato; marginem projiciente sterili in parte inferiore vinaceo. Lamellis albis, demum brunneis ubi laesae erant, confertis, 6 mm latis, liberis, collariatis; sporis in cumulo pallide auranticremeis. Stipite albo vel albido, saepe pallide vinaceo-tincto, demum dilute fusco vel fusco, fibrilloso ad apicem, glabro subtus, levi, attenuato, apicem versus vel aequali, initio ventricoso, saepe bulbo conspicuo albo praedito (18-20 mm lato), cavo, 50-60 x 9-12 mm (ad apicem); annulo duplico haud mobili sed demum saepe lacerato, margine superiore angustiore marineque inferiore vinaceo vel toto latere inferiore ceterum albo vel albido cum margine pilei continuo in juvenilibus, apicali, conspicuo. Carne alba autoxydatione brevi ferruginescente-fulvescente dein fuscescente, dein obscuriore, odore nullo vel aniseo. Sporis 5.8-6.5 x 4.3-4.8 μm, pseudoamyloideis, meachromaticis azureo cresylico, poro germinativo manifesto destitutis, membrana moderate crassa instructis, levibus; basidiis tetrasporis; (pleuro-) cystidiis nullis; epicute pilei trichodermio palisadico efformata, elementis trichodermii erectis, inter se parallelis, cylindraceis vel clavatis, interdum apice ampullaceis vel hyphoso-extractis, intus guttulis hyalinis, castaneis, fulvomelleis repletis, 25-63 x 8.8-13.2 μm; hyphis omnibus haud amyloideis, defibulatis. Ad terram in hortis.*"

TYPE STUDY OF SINGER T 396 (LIL) FIGS.1–3, 9

BASIDIOSPORES [40,1,1], 6–7.5(–8) × 4.5–5.5 μm, Q = 1.33–1.60, Q_{av} = 1.45, ellipsoid, hyaline, slightly thick-walled, without germ pore, dextrinoid,



Figures 1–3. *Leucoagaricus lilaceus*. (Singer T 396 [LIL]).
1: Basidiospores. 2: Basidia. 3: Cheilocystidia.
Scale bar = 10 µm.

congophilous, metachromatic in Cresyl Blue. Basidia 20–23 × 7–8 µm, clavate, hyaline, thin-walled, smooth, bearing four sterigmata 2–3.5 µm long. Pleurocystidia absent. Cheilocystidia 30–50 × 10–15 µm, usually narrowly clavate, clavate, mucronate and capitate but sometimes lageniform, hyaline, thin-walled, smooth. Pileipellis a cutis made up of prostrate hyphae with hyaline to grey pigment. Erect elements were not seen in the herbarium material. Clamp-connections absent.

Description of modern material — Fig. 4–8, 10

Pileus 35–75 mm, convex, plano-convex to applanate, with a low umbo; light brown (6.D5), reddish brown (9.D5) to violet brown (10.E6); with a velutinous surface, dry, densely covered with short and erect hairs brown to light-brown; regular margin exceeding lamellae; context thick, white. Lamellae crowded, free, membranous, white (1.A1) to cream (1.A2), changing to almost pink after dry (10.A4). Stipe 45–92 × 5–14 mm, central, with an abruptly bulbous base (12–27 mm), pink-brown, fibrillose surface, hollow, fibrous consistency; context pale-yellow; white rhizomorphs present at the base. Annulus

ascending, complex, halfway up stipe, pinkish with a dark serrulate margin at the top part, movable after drying. Odor pleasant. Spore print white (1.A1) to cream (1.A2).

Basidiospores [210,7,7], (5.5–)6–7(–9) × 4–5 µm, Q = 1.20–2.00, Q_{av} = 1.56, ellipsoid to oblong, hyaline, slightly thick-walled, without germ pore, dextrinoid, congophilous, metachromatic in Cresyl Blue. Basidia 18–22(–24) × 6–8 µm, clavate, hyaline, thin-walled, smooth, bearing four sterigmata 1.5–3 µm long. Pleurocystidia absent. Cheilocystidia (26–)30–60(–66) × (8–)10–16(–20) µm, with different forms (clavate, capitate, mucronate, lageniform), hyaline, thin-walled, smooth. Pileipellis a cutis with prostrate hyphae and erect terminal elements, 4–21 µm wide, with hyaline to grey or dark-grey intracellular pigment. Clamp-connections absent. Hymenophoral trama regular, with hyaline, thin-walled, smooth, cylindrical hyphae, 3–10 µm wide.

Habitat: growing solitary or in small groups on soil inside the forest.

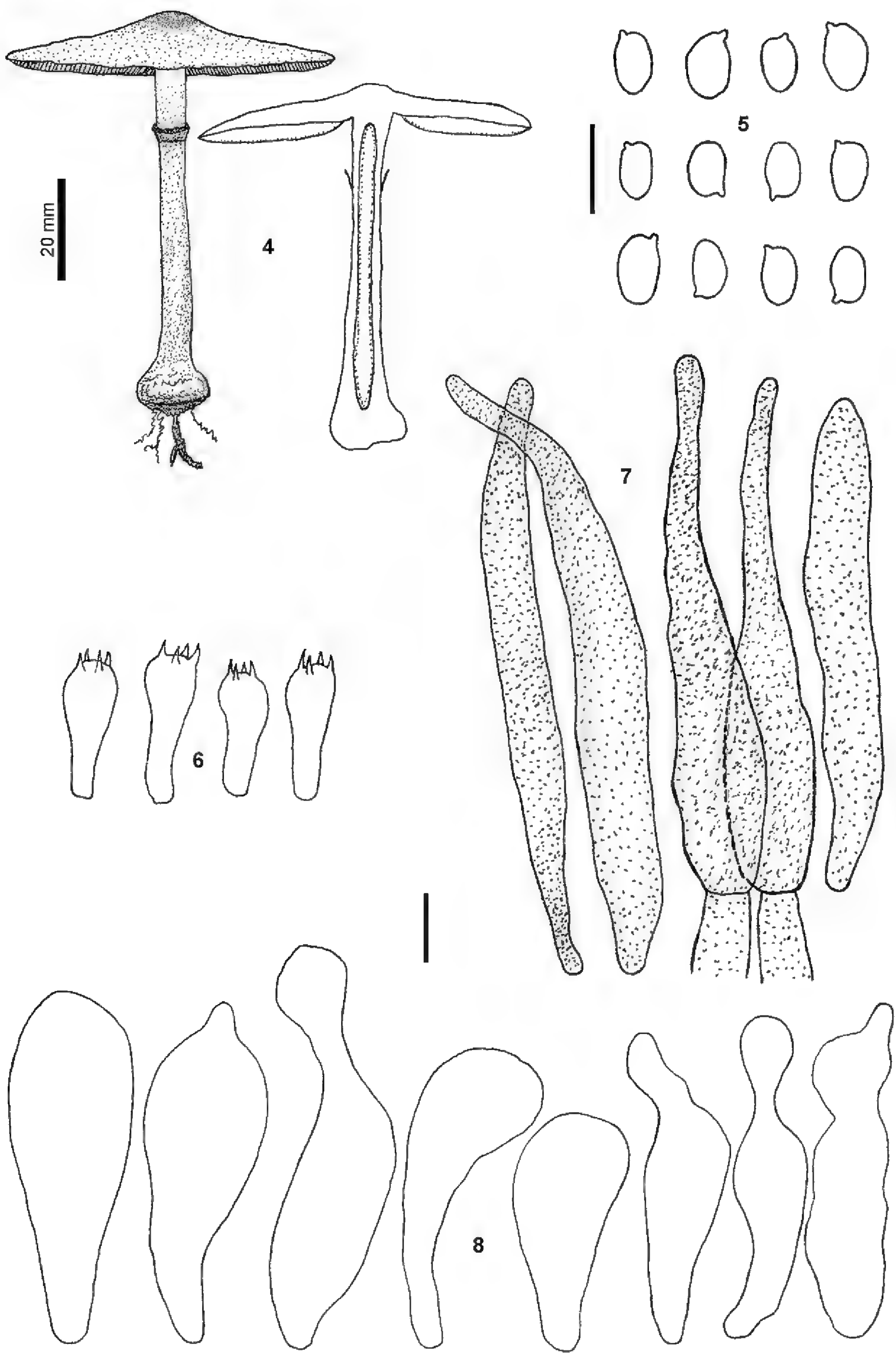
Recent specimens examined: BRAZIL. Rio Grande do Sul State. Viamão: Itapuã Park, Grota's Downhill, 16/IV/2005, M.S. Rother 041/05 (ICN 139314); Pedreira's Beach, 09/IV/2005, M.S. Rother 026/05 (ICN 139315); 06/X/2005, M.S. Rother 086/05 (ICN 139316); 22/X/2005, M.S. Rother 097/05 (ICN 139317); 27/I/2006, M.S. Rother 106/06 (ICN 139318). Porto Alegre: Farroupilha Park, 28/III/2007, M.S. Rother 138/07 (ICN 139319); M.S. Rother 139/07 (ICN 139320).

Additional specimens examined: ARGENTINA. Tucumán: Garden of the Institute Miguel Lillo, 09/IV/1949, leg. P. Antonuccio et Golbach, Singer T 396 (SYNTYPUS – LIL), Singer T 396 (BAFC 30539; 13/IV/1951, Singer T 1504 (SYNTYPUS – LIL); 28/XII/1951, Singer s/n (LIL); 16/II/1959, Singer (LIL); Avellaneda Park, 28/III/1951, Singer 1450 (LIL); Yerba Buena, 12/II/1955, Singer T 2164 (LIL).

Distribution: South America – northern Argentina (Tucumán): Singer & Digilio (1952) and southern Brazil (Paraná and Rio Grande do Sul): Meijer (2006); Sobestiansky (2005).

Remarks: This interesting species in *Leucoagaricus* Locq. ex Singer is placed in section *Piloselli* (Kühner) Singer based primarily on having lamellae that become pinkish with age (Singer 1986). It is a beautiful species, macroscopically characterized by the color of the basidiomata, the lamellae changing color with age, the abruptly bulbous stipe base with well developed rhizomorphs, and the annulus (movable after drying) with a serrulate margin.

Singer originally described *L. lilaceus* from Argentina (Singer & Digilio 1952). In his remarks, he did not mention key characters that would help diagnose it to species but merely noted that the species was extraordinarily beautiful and macroscopically easy to recognize. Singer also did not mention the presence of cheilocystidia (which we observed in both our own and Singer's collections). Through studying Singer's collections deposited in LIL and BAFC, we were able to confirm the identity of our collected specimens from southern Brazil.



Figures 4–8. *Leucoagaricus lilaceus*. (M.S. Rother 086/05).
4: Basidioma. 5: Basidiospores. 6: Basidia. 7: Pileipellis. 8: Cheilocystidia.
Scale bar = 10 µm (microscopic features).

Figure 9. Basidiomata of *Leucoagaricus lilaceus.* (Singer T 396).
Scale bar = 20 mm

The collection number cited by Singer & Digilio (1952) — T 306 09/IV/1949 — is incorrect; the labels on the type collections in LIL and BAFC read T 396. Singer & Digilio (1952) designated two collections as types (T 396 and T 1504); we prefer to treat those materials as syntypes because they were collected at different times.

Lepiota decorata Zeller, recently re-described from California (USA) and placed in *Leucoagaricus* sect. *Piloselli* based on morphology and molecular data (Vellinga 2007), is close to *Leucoagaricus lilaceus* in pileus color and microscopic characters but differs in the cylindrical stipe and the different annulus edge. This

Figure 10. Basidiomata of *Leucoagaricus lilaceus*. (M.S. Rother 097/05).
Scale bar = 20 mm.

species occurs in the USA and France. *Leucoagaricus sublittoralis* (Kühner ex Hora) Singer, known from Europe, comes close in general aspect, but differs in the absence of staining reactions, a non-bulbous stipe base, and cheilocystidial shape (Bon 1981, Candusso & Lanzoni 1990, Vellinga 2001).

After more than a half century since its discovery, *Leucoagaricus lilaceus* has only recently been recorded from Brazil, from the states of Rio Grande do Sul (Sobestiansky 2005) and Paraná (Meijer 2006). Neither author provided descriptions or pictures of their collections, and their material is not available for revision or loan. If Sobestiansky's (2005) *Leucoagaricus* cf. *lilaceus* cannot be confirmed as *L. lilaceus*, then our specimens represent a first confirmed record of the species from Rio Grande do Sul.

We have repeatedly collected *Leucoagaricus lilaceus* in the urban area of Porto Alegre, capital of the state Rio Grande do Sul, which suggests that the species should be considered common in the Porto Alegre metropolitan region and possibly throughout the state of Rio Grande do Sul as well.

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Chaetothyriomyces: a new genus in family *Chaetothyriaceae*

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Abstract—A new ascomycete genus in family *Chaetothyriaceae* found in the Brazilian Cerrado is described and designated *Chaetothyriomyces*, type-species *C. brasiliensis*.

Key words—fungal taxonomy, tropical fungi, mycodiversity, *Loculoascomycetes,* Brazil

Introduction

The phylogenic position of the *Chaetothyriales* / *Eurotiomycetes* segregated from the *Capnodiales* / *Dothideomycetes* is well documented (Winka et al. 1998). Two chaetothyriaceous families are generally accepted, viz. *Chaetothyriaceae* and *Herpotrichiellaceae* (Geiser et al. 2006). The *Chaetothyriaceae* accommodates those mostly epiphytic or plant parasitic genera associated mainly with tropical plants classically studied by Batista & Ciferri (1962) and confirmed by Luttrell (1973), von Arx & Müller (1975), and Barr (1987). This family includes genera with fungal thallus characterized by dark mycelium forming a net-like layer of monilioid hyphae, growing similarly to a sooty-mold on the surface of the host leaves and stems (Batista & Ciferri 1962). The *Herpotrichiellaceae* contains saprophytes with most anamorphs shown as black yeasts that, however, are human and animal parasites (Barr 1987, Untereiner & Naveau 1999, Untereiner 2000).

Presently eight genera are accepted in the family *Chaetothyriaceae* Hansf. ex M.E. Barr: *Actinocymbe* Höhn., *Ceramothyrium* Bat. & H. Maia, *Chaetothyrium* Speg., *Euceramia* Bat. & Cif., *Microcallis* Syd., *Phaeosaccardinula* Henn., *Treubiomyces* Höhn., and *Yatesula* Syd. & P. Syd. (Lumbsch & Huhndorf 2007). Collecting in wild cerrado areas and reserves led to the detection of a chaetothyriaceous species belonging in a new genus herein described.

Materials and methods

Starting in 1992, fungi on Cerrado vegetation were extensively collected from different regions representative of this extensive biome (Dianese et al. 1997). The specimens were properly processed and exsiccates deposited in the Mycological Collection of the Herbarium UB (UB Mycol. Col.). After observations under a stereomicroscope the samples were mounted on semi-permanent slides in lacto-glycerol/cotton blue or glycerol-KOH/basic floxine. Mounting media without stains were also used to determine the exact color of different structures. Detailed morphology was studied using a light microscope provided with a digital camera for measurements and photomicrography. The dimension ranges are followed by the median value in parenthesis.

Taxonomy

The last genus to be described in *Chaetothyriaceae* was *Euceramia*, type-species *Euceramia palmicola* Bat. & Cif., over forty years ago when Batista & Ciferri (1962) established the family *Euceramiaceae* Bat. & Cif. as part of the *Chaetothyriales*, but showing unitunicate asci. The *E. palmicola* type material was examined but neither asci nor the phragmosporic ascospores were found. Thus, new collection is needed because the most distinctive feature of the species (the presence of unitunicate asci) could not be confirmed. This diverging character would segregate the fungus from the remaining members of the *Chaetothyriaceae*. However, this fact does not interfere with the proposition of a new genus that is clearly different from *Euceramia* species described as having phragmosporic ascospores. Thus a new genus and type species showing 2-celled ascospores are now described, as follows:

Chaetothyriomyces Pereira-Carvalho, Inácio & Dianese, **gen. nov.**

MYCOBANK, MB 512105

Speciebus Microcallis *similis, sed asci 16-spori continentis. Coloniae superficiales. Mycelium supeficiale, brunneum vel atro-brunneum; pellicula reticulata fasciens. Hyphae septatae, ramosae, monilioides. Ascomata superficialia, subglobosa vel globosa, unilocularia, laevia; parietes textura globosa et angularis; sub pelliculis reticulatis locata. Asci clavati, bitunicati, 16-spori. Ascosporae hyalinae, bicellulares.*

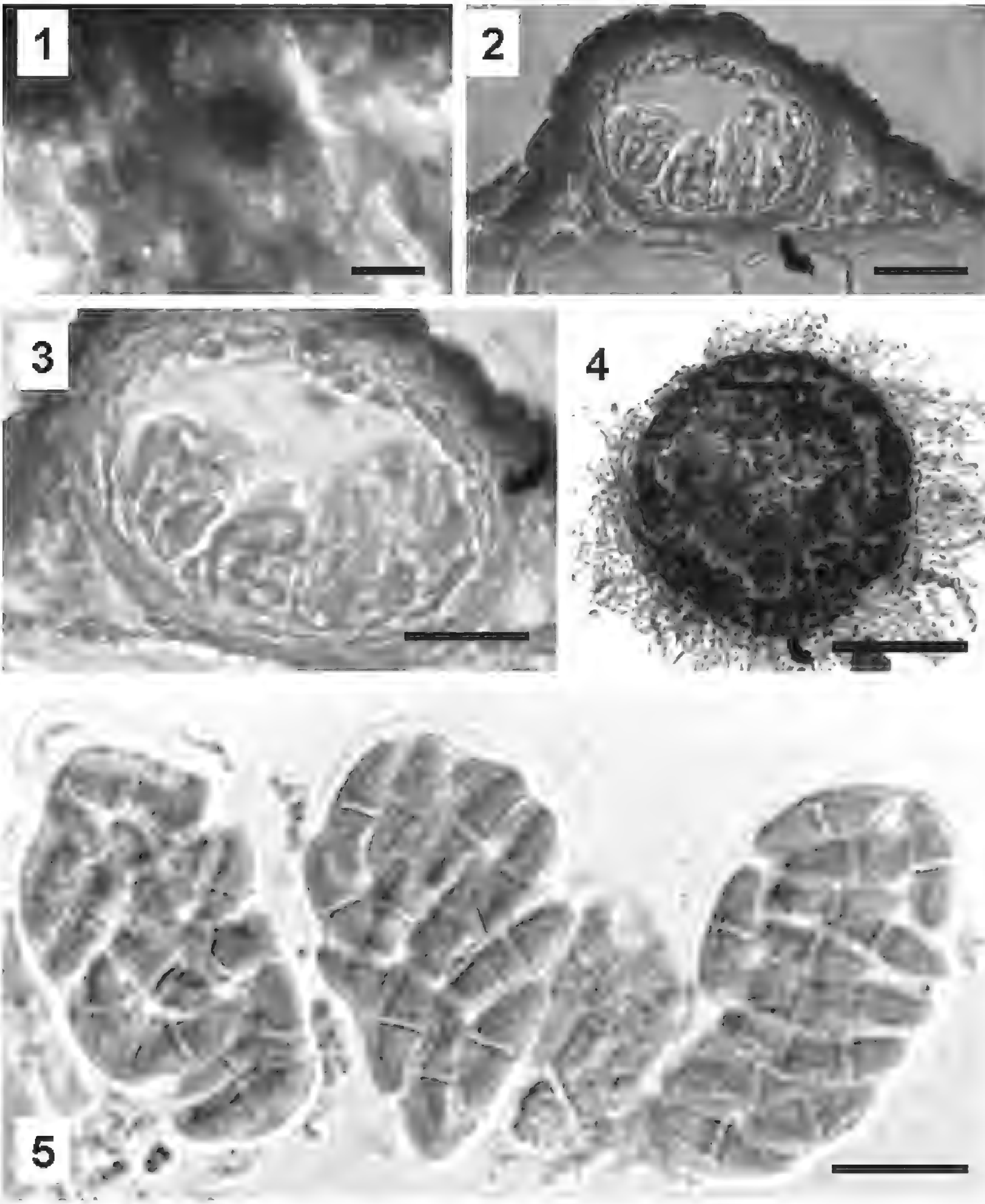
TYPE SPECIES: *Chaetothyriomyces brasiliensis* Pereira-Carvalho, Inácio & Dianese.

ETYMOLOGY: a fungus (*myces)* similar to members of the family *Chaetothyriaceae.*

Chaetothyriomyces brasiliensis Pereira-Carvalho, Inácio & Dianese, **sp. nov.**

MYCOBANK, MB 512643 FIGS. 1–5

Coloniae effusae, epiphyllae, superficiales. Mycelium superficiale, brunneum vel atro-brunneum, pellicula reticulata fasciens. Hyphae 7–19 (10) × 2–4 (3) μm, septatae, ramosae, monilioides, brunneae. Ascomata 76–130 × 51–74 μm, superficialia brunnea, subglobosa vel globosa, unilocularia, laevia; parietes textura globosa et angularis; sub



FIGS. 1–5. *Chaetothyriomyces brasiliensis* on a leaf of *Qualea grandiflora* (*Vochysiaceae*). 1. A dark ascoma seen under a stereomicroscope (bar = 100 µm). 2–3. Sections through an ascoma showing the disposition of the asci (bars = 20 µm). 4. An ascoma associated with a weft of superficial mycelium (bar = 50 µm). 5. Bitunicate asci with slightly asymmetrical ascospores.

pelliculis reticulatis locata. Asci 18–42 (31) × 16–34 (18) µm, late clavati, bitunicati, 16-spori. Ascosporae 8–15 (12) × 3–5 (4) µm, hyalinae, bicellulares, ellipticae, asymmetricae.

TYPE: **BRAZIL. MATO GROSSO DO SUL**, CAMPO GRANDE, Reserva Ecológica da Embrapa at Depate Empaer on living leaves of *Qualea grandiflora* (*Vochysiaceae*), 16 Ago 1996, *leg. M. Sanchez* 1892, **holotype** (UB Col. Micol. 12116).

ETYMOLOGY: in honor of the country of origin.

Colonies effuse, epiphyllous, superficial. Mycelium superficial, brown to dark brown, septate, forming a net-like pellicle. Hyphae 7–19 (10) × 2–4 (3) µm, septate, branched, monilioid, brown. Ascomata 76–130 × 51–74 µm, superficial, located under a mycelial pellicle, brown, dark brown, subglobose or globose, unilocular, smooth; wall with textura ranging from globose to angular. Asci 18–42 (31) × 16–34 (18) µm, broadly clavate, bitunicate, 16-spored. Ascospores 8–15 (12) × 3–5 (4) µm, hyaline, 2-celled, elliptical, non-symmetrical.

Additional specimens examined: **BRAZIL. Brasília**: Fazenda Água Limpa on living leaves of *Eugenia klotzschiana* (*Myrtaceae*) 21 Jul 1993, *leg C. Furlanetto* 150, **paratype** (UB Col. Micol. 19601). **Brasília**: Parque Nacional de Brasília on living leaves of *Qualea parviflora* (*Vochysiaceae*), 14 Aug 1995, *leg. A. S. Alves* 245, **paratype** (UB Col. Micol.. 9780).

Comment: The specimen studied is characteristically a member of the *Chaetothyriaceae* / *Chaetothyriales* M.E. Barr (Barr 1979, 1987; Kirk et al. 2001) with dark superficial mycelium typically containing septate monilioid hyphae, and forming a layer on top of globose sometimes setose perithecial ascomata depressed when dried with a pseudoparenchymatous thin-wall; clavate bitunicate asci with transversally septate or muriform hyaline to pale gray ascospores (Kirk et al. 2001). According to Kirk et al. (2001) *Chaetothyriaceae* includes the genera: *Actinocymbe*, *Biciliopsis* Diederich, *Ceramothyrium*, *Chaetothyrium*, *Euceramia*, *Microcallis*, *Phaeosaccardinula*, *Treubiomyces* and *Yatesula.* Recently, Lumbsch & Huhndorf (2007) considering also the available molecular data accepted the same generic composition for the family, except for *Biciliopsis* that was properly fitted in *Dothideomycetidae* incertae sedis. Among this set of genera in family *Chaetothyriaceae,* only *Euceramia* can be contested because of its described unitunicate asci (Batista & Ciferri 1962) and will not be considered here pending epitypification or neotypification. Thus, comparing the specimen with the remaining members of the *Chaetothyriaceae*, its species is segregated from all genera based on an outstanding character, namely the presence of sixteen ascospores in each and every ascus.

The following key to genera of the family *Chaetothyriaceae* clearly indicates that the new fungus belongs in a new genus, based on the same family characteristics traditionally adopted (Luttrell 1973, von Arx & Müller 1975, Barr 1987, Barr & Huhndorf 2001, Eriksson 1981, Lumbsch & Huhndorf 2007).

Key to genera of the family *Chaetothyriaceae*

1a. Asci bitunicate, 16-spored or more, ascospores 2-celled .... *Chaetothyriomyces*
1b. Asci bitunicate, 4–8-spored 2

2a (1b) Mycelium and/or ascomata setose 3
2b. Mycelium and ascomata glabrous 6

3a (2a) Ascospores 2-celled .... ***Microcallis***
3b. Ascospores multiseptate 4

4a (3b) Ascospores muriform .... ***Treubiomyces***
4b. Ascospores phragmosporic 5

5a (4b) Mycelium setose, ascomata setose or glabrous, ascospores vermiform to fusiform-elongate tapering towards the apex .... ***Actinocymbe***
5b. Mycelium setose, ascomata glabrous, ascospores ovoid to ellipsoid with rounded apices .... ***Chaetothyrium***

6a (2b) Ascospores phragmosporic, fusoid .... ***Ceramothyrium***
6b. Ascospores muriform 7

7a (6b) Superficial mycelium conspicuous .... ***Phaeosaccardinula***
7b. Superficial mycelium lacking or inconspicuous .... ***Yatesula***

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Book reviews and notices

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The last Book Reviews and Notices section appeared in Mycotaxon **102**: 431-456 (October-December 2007). It had been my intention to include the next one in the last volume of 2008, but I was unable to achieve this because of some problems with my eyes that have now appear to have been satisfactorily resolved. I wish to apologize to readers for this, which has meant that reviews have been slower in appearing than I would have liked. It is therefore planned to include a batch of Book Reviews and Notices in addition to the present one in the last issue of 2009.

General

Fungal families of the world. By Paul F.Cannon & Paul M. Kirk. 2007. CAB International, Nosworthy Way, Wallingford, Oxfordshire OX10 8DE, U.K. (e-mail: cabi@cabi.org). Pp. xiii + 456, col. illustrations *ca* 900. ISBN 978-0-85199- 827-5. Price £ 95.

This sumptuous, almost coffee-table, large-format book has its origins in an unpublished ascomycete course manual prepared for courses held at the then International Mycological Institute by Paul Cannon, David Minter, and me around 1990. The original concept of descriptions, illustrations, and key literature has been retained, but the text and illustrations have been rewritten and re-sourced respectively and now all phyla of kingdom *Fungi* are covered. Phyla traditionally treated as fungi but now placed in other kingdoms, notably the *Chromista* (*Straminipila*) and *Protozoa*, which they refer to as "fungal analogues," however, are not covered here. While I well appreciate the academic reasons for this spreading trend in mycological works, I perceive a danger of these "fungal analogues" becoming orphans of key reference works with none of their own.

[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor at Milford House, The Mead, P.O. Box 152, Ashtead, Surrey KT21 2LZ, U.K. (d.hawksworth@nhm.ac.uk). All unsigned entries are by the Book Review Editor.

A relatively short Introduction includes an impressive list of 88 mycologists who have contributed photographs, amongst whom George Barron, Yves Deneyer, David Ellis, Robert Lücking, Bill Malcolm, Jens Petersen, Einer Timdal, and Chris Walker are singled out for special mention. This is followed by a somewhat daunting six-page General Bibliography of key publications arranged alphabetically within phyla. Then follows the heart of the work — 383 pages devoted to 536 accepted families arranged in alphabetical order. For each family the author citation and date of valid publication is given, followed by the ordinal (where known) and phylum placement, description, note of "significant genera," information on distribution, economic significance, ecology, selected literature references, and in most cases illustrations – most of which are in colour. The illustrations make this a "must have" work, especially the coloured DIC photomicrographs, though the quality is somewhat variable. However, these and some of the macro-shots must be the first of the genera ever to appear in print in colour. A substantial glossary (53 pages) follows, and the work concludes with a list of accepted (in bold face) and frequently cited (in regular type) family names, with synonyms cross-referenced, and all with places of publication.

While the work was sufficiently up-to-date to include family names and some literature published in 2007, family classifications in many groups of fungi are still in flux and acceptance here should not be taken as the latest information available. For example, both family names treated on p. 15 (viz. *Aporpiaceae* and *Appendicisporaceae*), are now being treated as synonyms of *Auriculariaceae* and *Ambisporaceae* respectively.

There are the inevitable minor glitches, but it would be petty to comment on those. My only major "beefs" are the lack of an outline classification to show the families in the fungal hierarchy, and the lack of an index to genera mentioned in the text or figure legends. However, in general the book has been prepared meticulously, and the authors are to be congratulated on what will be seen as a major landmark work, and an essential companion and supplement to the recently published tenth edition of AINSWORTH & BISBY'S DICTIONARY OF THE FUNGI (Kirk et al. 2008)– which will be reviewed in the next series of MYCOTAXON Book Reviews .

Kirk PM, Cannon PF, Minter DW, Stalpers JA (eds) (2008) AINSWORTH & BISBY'S DICTIONARY OF THE FUNGI. 10th edn. CAB International, Wallingford.

Compendium of soil fungi. By Klaus H. Domsch, Walter Gams & Traute-Heidi Anderson. 2007. 2nd edn revised by W. Gams. IHW-Verlag, Postfach 1119, D-85378 Eching bei München, Germany (e-mail: dr.schmid@ihwverlag.de). Pp. 672, figs 382. ISBN 978-3-930-176-69-2. Price 149 €.

This new edition of the COMPENDIUM OF SOIL FUNGI is welcome for two reasons. The reprint of the first edition, already dated 1980, has been out of stock for

some years, and the subsequent numerous taxonomic and nomenclatural changes, as well as the accumulation of new data in the ecology, physiology and metabolism of those fungi, necessitated a revision. This revision was thankfully performed by Walter Gams. The number of compiled species, which was 209, has not changed much, but 52 name changes, mainly due to the development of molecular taxonomy, have been integrated. Eight generic names are no longer used, and 16 are added, bringing the total number of genera treated to 162. The genus *Memnoniella* disappears into *Stachybotrys*. Twelve species of *Gibberella*, *Nectria*, and *Emericella* are disposed under their anamorphic names in *Cylindrocarpon*, *Fusarium*, or *Aspergillus*. *Nectria inventa* is excluded as not a soil fungus, while *Acrostalagmus luteoalbus*, which is now disproved as being its anamorph, is accepted as a soil species. Some species of *Phialophora* are transferred to *Cadophora* and *Pleurostomophora*. Most former *Gliocladium* species are placed in *Clonostachys*, with *Sesquicillium* as a synonym. Species of *Verticillium* are disposed in *Lecanicillium*, *Pochonia* and *Gibellulopsis*. Several species of *Paecilomyces* are transferred to *Isaria*, *Paecillium*, and *Paranomuraea*. Four species of *Mortierella* are now to be found in *Umbelopsis*. It should be noticed that the names, *Myrmecridium* and *M. schulzeri* are effectively published in Studies in mycology 58: 57-94 (2007), and the new combination *Gibellulopsis nigrescens* appears in Nova Hedwigia 85: 463-489 (2007), while the reference in the book is indicated as "in press." The new generic and specific names, announced as to be published in 2008, *Paecillium* with *P. lilacinum* and *P. atypicola*, and *Paranomuraea* with *P. carnea* and *P marquandii*, as well as *Lecanicillium fungicola*, are here also considered as "provisional names" and so not effectively published in this book (Art. 34.1). Also to be mentioned is the use of a synonym instead of the correct name *Cylindrocarpon obtusiusculum* in the legend of Fig.108. A mass of new information from 333 recent publications is included, and added to the 7000 references from the first edition. This revised edition required Gams and his collaborators to transfer the original typography into a digital text, which enabled high quality printing by the IHW press.

Analysis of the soil mycobiota has become a necessary component in diverse research domains, such as agriculture, plant pathology, environment, hygiene, and medicine, in addition to mycology. Therefore, this handbook, the Compendium of soil fungi, remains a very necessary tool.

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Atlas of invertebrate-pathogenic fungi of Thailand. Vol. 1. By Janet Jennifer Luangsa-ard, Kanoksri Tasanathai, Suchada Mongkosamrit & Nigel Hywel-Jones. 2007. National Center for Genetic Engineering and Biotechnology (BIOTEC),

113 Thailand Science Park, Phaholyothin Road, Khlong 1, Khlong Luang, Thani 12120, Thailand (e-mail: lab@biotec.or.th). Pp. 82, col. plates 31. ISBN 978-974-229-522-6. Price US $ 35.

This volume deals with 31 species of entomopathogenic fungi belonging to the genera *Akanthomyces* (3 spp.), *Aschersonia* (8), *Beauveria* (2), *Gibellula* (2), *Hirsutella* (1), *Hypocrella* (2), *Isaria* (5), *Metarhizium* (2), *Nomuraea* (1), *Ophiocordyceps* (4), and *Paecilomyces* (1). Nigel Hywel-Jones is one of the leading world specialists on entomogenous hypocrealean fungi, and, along with ten other contributors, he has now started to document his favourite fungi in Thailand. Each species has a double-page spread: that on the left has the accepted name and synonyms (with places of publication of the names), an indication of any anamorph-teleomorph connection, a description of the species in nature and in culture, and indication of the distribution, and key references; the facing right-hand pages have composite colour plates showing the species on a host, with sections, squashes, and cultures. The plates are extraordinarily glossy, and appear to have been produced by an unusual but very successful method. This new volume must inevitably be compared with that of Tzean et al. (1997) on the entomopathogenic fungi of Taiwan, which they cite. That book has keys and includes many more species, and has fuller descriptions as well as line drawings of critical microscopic features as well as coloured habit macro-photographs and half-tone microscopic ones; they also cite the actual specimens examined. The Thai work will certainly become more useful to those working on entomogenous fungi in the tropics as further volumes are issued, and especially if more aspects of the Taiwanese book can be emulated.

Tzean SS, Hsieh LS, Wu Wj (1997) Atlas of entomopathogenic fungi from Taiwan. Council of Agriculture, Taipei, Taiwan.

Topicós sobre diversidad, ecología y usos de los hongos microscópicos en Iberoamérica. Edited by Gabriela Heredia Abarca. 2008. Instiuto de Ecología A. C., Km 2.5 Carretera Antigua a Coatepec 351, Congregación El Haya, Xalapa 91070, Veracruz, México (e-mail: gabriela.heredia@inecol.ed.mx). Pp. 372, illustrated. ISBN 970-709-104-5. Price none (free while stocks last).

This multi-authored book, which has been prepared by 15 authors from six Spanish-speaking countries, is the product of a four-year project under the Programa Iberoamericano de Ciencia y Tecnología el Desarrollo (CYTED) initiated in 2003 to examine the diversity, ecology, and uses of microscopic fungi in Iberia and Latin America. It starts with a well-illustrated overview of microscopic fungi, their physiology, reproduction, life-styles, roles in ecosystem processes, and chemical products. Eighteen chapters are arranged under the three topics of diversity, ecology and uses, with six in each. All chapters are in Spanish, but each has a short abstract in English.

Those in "Diversidad" address saprobic hyphomycetes from native forests in Argentina, conidial fungi in the semi-arid regions of Brazil, soil ascomycetes in Spain, saprobic conidial fungi in Mexico, strategies for the conservation of fungi in Cuba, and the application of phylogenetic methods to the classification of conidial fungi. Under "Ecología" the chapters are concerned with interactions in soil, the rhizosphere, species in soil in an *Araucaria-Nothofagus* forest, effects of farming soil on *Glomeromycota*, species associated with orchids, and enzymes involved in arbuscular mycorrhizas. And under "Usos" are contributions on biological potential and chemical products, entomopathogens and possible applications in agriculture in Chile, bioconversion of oil mill residue, laccases and their biotechnological potential, and potential for the biodegradation of hydrocarbons.

The book has evidently been lovingly carefully prepared and edited. The chapters are well illustrated, with many photographs, diagrams, and highlights in tables making it pleasing to read. The cross-Atlantic dialogue that has led to this work is most welcome, and while the result is no comprehensive overview of the diversity of microfungi in Iberia or Latin America, it does provide an indication of their importance and potential in the regions. This will be valuable when making cases for funding mycological work, and also includes much material that can be used in teaching applied mycology. It is gratifying that this is yet another example of a book made available free with the support of funding agencies in a Spanish-speaking country, in this case through the project funding from CYTED. This an information dissemination model that merits emulation by other national regional, and international agencies. I encourage Spanish-speaking mycologists involved in teaching to request a copy while stocks are still available.

Glossário ilustrado de micologia. By Jair Putzke & Marisa Terezinha Lopes Putzke. 2004. EDUNSIC, Av. Independêcia2293, 968150900 Santa Cruz do Sol – RS, Brasil (e-mail:editor@unisc.br). Pp. 152, illustrated. ISBN85-7578-062-X. Price RS 45.

The availability of glossaries in national languages is important to the development and teaching of mycology. Today, Portugal has a thriving mycological community, and while attending the fifth Congresso Brasiliero de Micologia in Recife in 2007 I encountered this attractive glossary prepared by two colleagues who had previously produced Os reinos dos fungos (2002, 2 vols, EDUNSIC, not seen). This is the first glossary in Portuguese to come to my attention since the longer Dicionário micológico of Fidalgo & Fidalgo (1967). It covers all groups of fungi, including lichens, and in addition to descriptive and developmental terms has entries for organizations and collections, some chemical products, diseases caused by fungi, life-styles, and even short biographies. It is neatly illustrated with a mixture of half-tone

photographs and line sketches. While not on the scale of Ulloa & Hanlin's (2006) dictionary in Spanish (reviewed in Mycotaxon 102: 431-434, 2006), this little glossary is sure to be a boon to the new generation of Portuguese-speaking mycologists on both sides of the Atlantic.

Fidalgo O & Fidalgo MEPK (1967) Dicionário micológico. Rickia, suppl. **2**: 1-232.

Ulloa M & Hanlin RT (2006) Nuevo diccionario illustrdo de micologia. American Phytopathological Society Press, St Paul, MN.

Tesoros de nuestros montes: trufas de Andalucía. By Baldomero Moreno Arroyo, Javier Fernández Gómez & Elena Pulido Calmaestra. 2005. Consejería de Medio Ambiente, Junta de Andalucía, Avenida Manuel Siurot 50, ES-41071 Sevilla, Spain (http://www.juntadeandalucia.es/medioambietale/sitWeb/contactar/). ISBN 84-96329-68-2. Price 24 €.

"Sumptuous" immediately came to mind when I first paged through this hefty book. Its large size (50 × 27 cm), high quality paper, the magnificent, full color illustrations gracing most of its pages, and even the endpapers that feature a beautiful enlargement of the patterned gleba of a *Tuber* species are consonant with its title, "Treasures of our mountains: truffles of Andalucía." It even has a fabric bookmarker sewn into the binding, a feature not often seen in books published after the 19th century. The list price is amazingly low for books of this quality, which nowadays commonly sell for 100 US$ or more. That said, let us consider the content.

The book is divided into six parts. After 14 pages of title, table of contents, acknowledgments, etc., Part 1 consists of about 90 pages of introduction with ten chapters: what truffles are; truffles in the world; the truffles of Andalucía; anatomy, composition and biological cycle; the union of the three kingdoms (plants, fungi and animals); the truffle in the Andalucian mediterranean woodlands; use and value of truffles; how truffles are hunted; truffle cultivation: harmony between nature and economics; and conservation of wild truffles. Part 2 of about 200 pages is the guide to the 81 species found to date in Andalucía, including an illustrated description of all species except *Zygomycota* and *Glomeromycota,* together with a listing of species with synonyms, and keys to the accepted species. Finally, Parts 3-6 are respectively a glossary of technical terms, a bibliography, a list of abbreviations used, and a species index.

Part 1: Introduction: about truffles

Chapter 1, "What are truffles?," opens with a dramatic painting of lightning, tree roots, mycorrhizae and truffles to introduce truffles in history, including ancient speculations (myths) about their origin. A new one to me is that they come from the testicles of Adonis, buried and multiplied by The Furies. Indeed, one Spanish term for a truffle is "turma de tierra," literally a testicle of the earth (we'll return to "turma" later). The relationship of hypogeous to epigeous

fungi is briefly noted. Chapter 2 deals with truffles around the world, "truffles" here referring to all hypogeous fungi. The authors make the interesting point that most knowledge about truffles has been developed in the 30 % of Earth's land surface, that lying between 30° and 60° N. The well-known truffles of the southern African Kalahari Desert are not mentioned. Speciation endemic to various continents is briefly discussed. Chapter 3 introduces the truffles of Andalucía, noting the excellence of oaks as mycorrhizal hosts, and listing more than 40 species associated with oaks. These chapters are brief, intended to alert readers to these considerations but not deal with them in detail.

Chapter 4, on anatomy, composition, and the biological cycle of truffles, initiates the details of truffle anatomy. The text is sparse but more is not needed, because each anatomical structure important in taxonomy is splendidly illustrated by outstanding, crisp, color photographs. The peridial warts of *Tuber aestivum* are shown with commendable clarity. Spores, asci, and basidia are similarly excellent, with examples of both light and scanning electron micrographs. The chapter continues with a truncated discussion of nutritional components of selected species, and a well illustrated, readily understandable, explanation of the tree → mycorrhiza → primordium → truffle → mycophagist → tree cycle. This is followed by Chapter 5 on the "union of the three kingdoms": plant, fungus, and animal. Spore dispersal by animals, including insects and snails, is noted.

An overview of ecology and distribution of truffles in the mediterranean woodlands of Andalucía is presented in Chapter 6. Soils, vegetation, soil fauna, and their relationships to truffle occurrence are described and, no longer surprisingly, wonderfully illustrated by color photographs and paintings. Chapter 7 reviews the use and exploitation of truffles in medicine, gastronomy, and the emergent mycotourism engendered by the mystique of truffles and other edible fungi. Truffle hunting is reviewed in Chapter 8, from pigs and dogs to truffle flies, use of plant indicators, and probing the soil with a pointed staff, to electronic truffle "sniffers." The authors do not believe that electronics will replace the amazing diligence and precision of dogs.

Chapter 9 is titled "the cultivation of the truffle: harmony between nature and economics." The discussion of truffle cultivation is general and not meant to replace the many detailed handbooks on the topic. The term "turmicultura," i.e. truffles of the semi-arid mediterranean matorral (shrublands) and forb/grasslands, is introduced to differentiate them from "Truficultura," referring to species associated with forest trees. As noted above, the term "turma" has a double meaning, so it does not translate readily into other languages. In this book, any truffle associated with mediterranean shrublands is termed a "turma." A turma named for a person, e.g. *Elaphomyces trappei*, is given the common name "turma de Trappe": I was uncertain whether to be pleased or

apprehensive, given how The Furies treated Adonis. In any event, the authors point out that mycorrhization with turmas can be incorporated into programs of using shrubs for erosion control to produce double benefits. A brief discussion of that concludes the chapter.

Moreno Arroyo has long been concerned about conservation and sustainability wild edible fungi. The book treats this topic in considerable detail, with emphasis on truffles. The chapter reflects the considerable thought he has given to the topic; it laid the foundation for the 1st World Conference on the Conservation and Sustainable Use of Wild Fungi in 2007 at Córdoba, which he organized with his colleagues under auspices of the Consejería de Medio Ambiente (Junta de Andalucía 2007a). One product of the conference was the "Fungi of the Earth: Declaration of Córdoba" approved by participants (Consejería de Medio Ambiente, Junta de Andalucía 2007b). The Chapter includes a four-page action plan, and the Declaration itself is reproduced in MYCOLOGICAL RESEARCH 112: 485–486 (2008). These documents deserve study by all concerned about the conservation and sustainable use of wild fungi.

Part 2: Guide to species

This part, comprising more than half of the book, begins with an outline of the classification (phylum, order, family, genus) of the 81 taxa described and illustrated in the ensuing pages. Unfortunately, herein lies the major weakness of this otherwise commendable book. The taxonomy and nomenclature are based on the 1995 edition of AINSWORTH & BISBY'S DICTIONARY OF THE FUNGI (Hawksworth et al. 1995). That edition was issued just as molecular tools were coming into widespread use in phylogenetic analysis, and even as it appeared it was becoming out of date, especially at the ranks of family and above. Consequently, the taxonomy used by Montero Arroyo and his colleagues is woefully dated back to the early days of fungal molecular phylogeny. In fairness to the authors, much of the new phylogenetic evidence (as presented in Spatafora et al. 2007) was published after the book went to press. Nonetheless, most of the changes for hypogeous fungi were published by 2003, which I guess would have been the last year in which corrections could have been made to the book's manuscript.

This problem does not affect keying out of the genera and species, except that they are organized by phylum, order, and family in the keys. Consequently, the key user bounces needlessly amongst obsolete names of orders and families to get to the name of the specimen in hand. The following tabulation presents updates — as of early 2009 — for those who want to annotate their copy. Genera that need their order and/or family assignments corrected are listed in the order presented on pp. 103-105 of the book (genera with correct order and family assignments are excluded from this tabulation). Currently accepted names of genera, orders, and families are in boldface in the tabulation, obsolete

names are in standard font in parentheses followed by an arrow pointing to the corrected name in boldface. Names that are correct in the book are simply alone in boldface.

Glomeromycota (only the order is given in the book's outline of classification)

Glomus: *(Zygomycota)* → ***Glomeromycota****; (Glomales)* → ***Glomerales****;*
(Glomaceae) → ***Glomeraceae***

Ascomycota **(all *Pezizales*)**

Balsamia*: (Balsamiaceae)* → ***Helvellaceae***
Picoa*: (Otideaceae)* → ***Pyronemataceae***
Choiromyces*: (Helvellaceae)* → ***Tuberaceae***
Fischerula*: (Helvellaceae)* → ***Morchellaceae***
Hydnotrya*: (Helvellaceae)* → ***Discinaceae***
Genabea*: (Otideaceae)* → ***Pyronemataceae***
Genea*: (Otideaceae)* → ***Pyronemataceae***
Geopora*: (Otideaceae)* → ***Pyronemataceae***
Hydnocystis*: (Otideaceae)* → ***Pyronemataceae***
Labyrinthomyces*: (Otideaceae)* → ***Tuberaceae***
Delastria*: (Terfeziaceae)* → ***Pezizaceae***
Pachyphloeus*: (Terfeziaceae)* → ***Pezizaceae***
Terfezia*: (Terfeziaceae)* → ***Pezizaceae***

Basidiomycota

(Endoptychum) → ***Chlorophyllum: Agaricales****; (Secotiaceae)* → ***Agaricaceae***
Gautieria*: (Gauteriales)* → ***Gomphales; Gautieriaceae***
Gastrosporium*: (Hymenogastrales)* → ***Phallales;***
(Gastrosporiaceae) → ***Clathraceae (?)***
Chondrogaster*: (Hymenogastrales)* → ***Hysterangiales;***
(Hymenogastraceae) → ***Mesophelliaceae***
Descomyces*: (Hymenogastrales)* → ***Agaricales;***
(Hymenogastraceae) → ***Bolbitiaceae***
Hymenogaster*: (Hymenogastrales)* → ***Agaricales; Hymenogastraceae***
(Octavianina) → ***Octaviania****: (Hymenogastrales)* → ***Boletales;***
Octavianinaceae → ***Boletaceae***
Sclerogaster*: (Hymenogastrales)* → ***Geastrales;***
(Octavianinaceae) → ***Sclerogastraceae***
Wakefieldia*: (Hymenogastrales)* → ***Boletales (?);***
(Octavianinaceae) → ***Boletaceae (?).***
Melanogaster*: (Melanogastrales)* → ***Boletales;***
(Melanogastraceae) → ***Paxillaceae***
Hysterangium*: (Phallales)* → ***Hysterangiales; Hysterangiaceae***
Phallogaster*: (Phallales)* → ***Hysterangiales;***
(Hysterangiaceae) → ***Phallogastraceae***
Gymnomyces: Russulales*; (Elasmomycetaceae)* → ***Russulaceae***
(Zelleromyces) → ***Arcangeliella****: (Elasmomycetaceae)* → ***Russulaceae***

After the outline of classification, come the descriptions of individual species. Each hypogeous (as opposed to "subhypogeous") species is illustrated by a superb color photo of sporocarps with surface and cross-sectional views, spores, representative plant associates, and a map of its known distribution in Andalucía. Macro- and microscopic characters are adequately described in the text. Habitat, fruiting season, and distribution are briefly discussed, followed by some general observations. Most species are given two full pages, one of which is the sporocarp photo. A line drawing of sporocarps is also presented; because the drawing adds little or no information to that provided by the color photograph, that space might have been better used for additional text.

Six "New" taxa are given four pages each, thereby allowing additional color photos of both macro- and micro characters. The introduction to the guide states that "For new taxa a Latin diagnosis is included as is required," and that is indeed done. Close inspection, however, reveals that none of these species are newly described in this book. All were validly published in journal articles between 1998 and 2002, so the Latin diagnoses in the book are superfluous.

"Subhypogeous" taxa are treated separately, and include substipitate sequestrates or partly submerged ascomycetes such as *Sarcosphaera* and several *Geopora* species. Each of these is allotted one page with a color photograph of sporocarps. The text material covers the same ground as for the hypogeous taxa.

For the most part, species identifications and nomenclature appear to be good, although I question a few. These problems are due more to a lack of adequate generic monographs and a need for molecular data than to any lack of diligence by the book's authors. *Choiromyces gangliformis* is actually an immature specimen of *C. meandriformis*, the latter name having priority. Molecular studies have shown few hypogeous species overlap between North America and Europe, even though some are morphologically similar. With that in mind, I question the identifications of *Genea compacta* and *G. thaxteri*, both first described from North America. *G. compacta* was originally described as brown and lacking peridial hairs, whereas the collection from Andalucía is blackish brown to black and has peridial hairs; it may actually be *G. pulchra*. *G. thaxteri* from Andalucía is dark brown to blackish and has slightly larger spores than the brown type from North America. The book's illustration of *Geopora cooperi* shows minute peridial warts, a feature lacking in specimens from North America where the species was originally described. These Andalucian collections need restudy. The book's *Rhizopogon roseolus* actually conforms to the quite different *R. vulgaris*, Index Fungorum notwithstanding.

I noticed a few errors in author citations: "*Hysterangium clathroides* Vittad. var. *clathroides* Vidal" should drop "Vidal," as the varietal epithet is an autonym, i.e., the name of the type variety with is automatically fixed by the species name. Occasional other errors here and there are trivial.

A list of synonyms for each species follows the descriptions, and in turn is followed by the keys, which are easy enough to use. The nomenclatural confusion at order and family ranks as noted above does not interfere with the use of the key so long as they are ignored.

Parts 3 – 6

These parts consist of a glossary, bibliography, list of abbreviations, and index to species, respectively. All are useful, but literature citations from after 1999 are scarce, reflecting in part the lack of attention to molecular advances in our understanding of phylogeny of hypogeous fungi.

Conclusions

At its very reasonable price, this book is worthy for the beautiful illustrations alone. Beyond that, the introductory chapters overview the range of truffle phenomena: history, traditions, biology, ecology, uses, harvesting, cultivation, conservation and sustainability, and taxonomy. I am far from fluent in Spanish, but with a Spanish-English dictionary at hand I found the text easy to read. The authors are particularly thoughtful about conservation, sustainability, use of some species as mycorrhizal inoculum in erosion control programs, and the importance of public education in all these activities. Although the focus is on truffles of Andalucía, it well represents the hypogeous mycobiota of the mediterranean oak woodlands and semi-arid shrublands. Its primary flaw, the outdated nomenclature above the genus level, needs to be recognized, but does not impede use of the book for species identification. I hope the authors will be able to issue a revised and corrected edition in the not too distant future.

Consejería de Medio Ambiente, Junta de Andalucía (2007a) 1st World conference on the conservation and sustainable use of wild fungi: technical presentations and posters. Consejería de Medio Ambiente, Córdoba.

Consejería de Medio Ambiente, Junta de Andalucía (2007b) Fungi of the earth: declaration of Córdoba. Consejería de Medio Ambiente, Córdoba.

Hawksworth, DL, Kirk PM, Sutton BC & Pegler DM (1995) Ainsworth & Bisby's dictionary of the fungi. 8th edn. CAB International. Wallingford. 616 pp.

Spatafora JW, Hughes KW, Blackwell M (eds.) (2007) ["2006"] A phylogeny for kingdom *Fungi*: Deep Hypha Issue. Mycologia 98: 829-1105.

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Manual de truficultura Andalucía. By Marcos Morcillo Serra, Baldomero Moreno Arroyo, Elena Pulido Calmaestra & Mónica Sánchez Sánchez. 2007. Consejería de Medio Ambiente, Junta de Andalucía, Avenida Manuel Siurot 50, ES-41071 Sevilla, Spain (http://www.juntadeandalucia.es/medioambietale/site/Web/contactar/). Pp. 176, illustrated. ISBN 978-84-935194-3-8. Price not indicated.

This delightful small-format guide to truffle cultivation is partly based on the above, but the main emphasis is on the practicalities of cultivation and production in the Province of Andalucía.

Chytridiomycetes, Oomycetes, and Protozoans

Brazilian zoosporic fungi. By Adauto Ivo Milanez, Carmen L. A. Pires-Zottarelli & Alexandra L. Gomes. 2007. Instituto de Botânica, Caixa Postal 3005, São Paulo, SP 01061-970, Brasil. Pp. 112. ISBN 978-85-907435-0-7. Price not indicated.

This is essentially a checklist of the zoosporic fungi of Brazil, including 328 species, which represents an increase of 46 % since the last compilation by the first author in 1999. These belong to *Plasmodiophoromycetes* (4 spp.), *Chytridiomycetes* (129), *Hyphochytridiomycetes* (4), *Labyrinthulomycetes* (4), and *Oomycetes* (187). For each species the original place of publication of the name is given, followed by details of the Brazilian collections with states, localities, source (including host plants), and literature references. That the references now extend over 22 pages testifies to the heightened interest in these fungi that has occurred in Brazil over the last ten years. The work also has an index to species and one to hosts. For some reason that escapes me, the author citations of hosts are given in the host index; they would have been better omitted entirely from the work, as this is not a plant taxonomic treatise! In summary, this will be a key reference work for all mycologists and plant pathologists concerned with zoosporic fungi and the diseases they cause in Brazil.

Zygomycetes

Guía de bolsillo de las Zigomicosis Invasoras. Edited by Amalia del Palacio, José Pontón, Josep Guarro & Guillermo Quindós. 2008. Revista Iberoamerica de Micología, Apartado 699, ES-48080 Bilbao, Spain. Pp. xi + 105, col. illustrations. ISBN 978-84-612-1887-5. Price not indicated.

This little booklet, in Spanish, comprises ten chapters, which collectively provide a synopsis of the fungi involved in zygomycoses, their clinical morphs, methods of diagnosis, and therapeutic treatments. It includes information on the incidence of these mycoses, predispositions to infections, and mortality rates. While not primarily a systematic work, this will be a useful addition to the shelves of mycologists in medical pathology laboratories.

Basidiomycetes

A manual and source book on the boletes and their allies. By Roy Watling. 2008. Fungiflora, P.O. Box 95, Blindern, N-0314 Oslo, Norway (e-mail:leif.ryvarden@bio.uio.no). Pp. 248, plates 17. [Synopsis fungorum vol. 24.] ISBN 978-82-90724-36-3. Price 300 NOK.

This is a welcome addition to the series that has recently, in the main, dealt with non-European species. It is a reference volume that contains much needed information on this group, which was unavailable in a comprehensive, form till now. The editors have made an admirable choice of author by inviting Professor Roy Watling to prepare this volume.

Many people know of my interest in *Boletus*, and therefore this new publication is "a must for my own bookshelf." However, this book holds countless amounts of information that Roy has accrued whilst enjoying a lifetime in mycology, and these would be of interest for the more generalist mycologist.

In the introduction he says "The outline of this book is quite simple, in that all genera currently placed in the *Boletales* are arranged alphabetically;" indeed all 79 genera are covered. Then, where appropriate, the history of each genus is comprehensibly described – on reading this adeptly written section, I realized to my shame how little we all really know about *Boletaceae* taxonomy. After that, are interesting chapters on rejected names, genera & families and ecology, but it is the key to genera that really is impressive, well written and very informative. This all relates wonderfully to the 17 plates which are very descriptive sketches prepared by the author in his "unique way," a style that we have come to recognize from his many other publications. His last sentence reads: "This book attempts to be as up-to-date as possible," a bold statement indeed in the fast changing world of molecular studies, but correct in most parts, especially considering he has been working on this massive task for only 12 months.

A very good 11-page glossary is included, in addition to two reference sections and 26 pages of specific references; all this useful information is now in one volume when previously it was hard to find when it was needed.

My only disappointment is that the copy I am using is already coming apart, with the pages falling out due to defective finishing at the printers. Yes, I have used it a lot, and I am sure that others will in the future. It is well worth having on your bookshelf. Thank you, Roy Watling, for this work.

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Monograph of *Marasmius*, *Gloiocephala*, *Palaeocephala* and *Setulipes* in tropical Africa. By Vladimir Antonín. 2007. National Botanic Garden of Belgium, Domien van Bouchut, B-1860Meise, Belgium. Pp. 1173 pp., col. plates19, half tone figs119. [Fungus flora of tropical Africa. Vol. 1.] ISBN 978-90726197-30. Price 50 €.

This publication, the first part of many I hope, is a logical continuation of Flore iconographique des champignons du Congo and Flore illustreé des champignons d'Afrique Centrale which it is proposed to replace in the years to come. This commencing part sets a standard that will be hard to follow. The Foreword by Jan Rammeloo and Jérôme Degreef describes the history of the concept of a Fungus flora for tropical Africa and the aspirations of the authors and editors to improve our knowledge of African biodiversity.

What better to commence the work with a monograph of *Marasmius* and its allies, because they are widespread in the tropics and appear to be always present when on collecting trips to the rainforest.

After a short introduction to the macro- and micro-characters used in identification, the reader is plunged directly into the taxonomic part with an interesting history of *Marasmius* collecting in Africa. A very useful key is offered to the marasmioid and collybioid genera, which will undoubtedly stand the test of time for those working in the field even though molecular data is showing that many constituent elements are polyphyletic. A key follows to the sections, subsections and series of *Marasmius*, which will be seen to draw strongly on the earlier work by Singer; indeed that author made a contribution on *Marasmius* in the Congo and environs in 1965 in part of the Flore iconographique.

The work is divided into nine sections with four subsections and a handful of series covering in all 102 different taxa. Some sections are represented by a single member, such as *Fusicystidiae* with *M. longicystidiata*, or a whole host of species as is found in sect. *Globulares* with 22 members. With each section there is a key to assist in identification. Each species is fully described both as seen in the field and after microscopic examination, and all are illustrated with line drawings of the salient features. The ecology, distribution (as some of the species are not confined to tropical Africa), and material (sometimes with revised classical collections), are fully documented with an additional section on notes on it and related taxa.

The same formula is used for *Gloiocephala*, with *Palaeocephala* with a single species incorporated into the key, and *Setulipes*, a genus described by Antonín in 1987 to cover *Marasmius* sect. *Androsacei*. Thus, the familiar Horse-hair fungus is now allocated to a separate genus. There are seven species described for each of these two genera.

Most species are illustrated in colour, either by watercolours or photographs obtained from a series of sources. Most will be helpful in identification, but the quality, as one might expect, varies because of the various sources. One source

used is Mme M. Goossens-Fontana dating back to her time as a drawing teacher based in the Eala Botanic Garden, Congo in the 1920s, and on which the Flore iconographique was strongly based. The coloured plates number 19 and follow all the keys translated into French. This is an important and admirable addition, as many of the field workers will have French as their adopted tongue. Before these keys, there is a considerable compilation devoted to excluded and doubtful species, covering 15 pages; it makes interesting reading. Seventy-five names published in *Marasmius* from Africa, many introduced by P. Henning, are considered based either on the original description, because material is not available, or after an examination of the type or authentic material.

This publication is a must for anyone studying the marasmioid/collybioid agarics wherever they may be stationed, and it is an example of extraordinary careful work. I knew this work was in progress, and it has taken some time to come to fruition, but it has been well worth waiting for.

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Fungi of Cameroon: Ecological diversity with emphasis on the taxonomy of non-gilled hymenomycetes from the Mbalmayo forest reserve. By Clovis Douanla-Meli. 2007. J. Cramer in der Gebrüder Borntrager Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany (e-mail: mail@schweizerbart.de). Pp. viii + 410, figs 172, tables 17. [Bibliotheca mycologica No. 202.] ISBN 978-3-443-59104-5. Price 89 €.

This publication is an extremely inspirational document, though sometimes it has rather quaint phraseology, which makes the reader stop and read again for clarity.

The main part of the book (289 pp.) comprises excellent descriptions of the non-gilled hymenomycetes found along eight plotless transects of 1000 × 20 m in four land-use types (near primary lowland forest, old-growth secondary forest, cleared areas with fallow of different stages and cropland) within the Mabalmayo forest reserve, situated in southern central Cameroon. All are supported by clear and effective line drawings and keys. There are 140 species described including 11 gasteromycetes (Birds' nest fungi and one stinkhorn) and 10 jelly fungi; 11 new species are described and a single new combination is made; and 75 are new records for Cameroon. The classification adopted is primarily on macro-morphology, using such groupings as stereoid fungi. stipitate stereoids, clavarioid fungi, etc. Such a treatment is useful, although it does not reflect natural groupings now revealed by molecular studies. This section is where the non-gilled part of the title is evident but the 'topping and tailing' of this descriptive data is full of equally important information.

Although the full title is explanatory, I doubt whether the reader realises when opening the book what a mine of information there is between the pages, and so full appreciation of the work involved may not at first be appreciated. There is certainly more to this volume other than non-gilled forms, as information on such topics as the distribution and ecology of agarics and larger ascomycetes are also addressed. I was amazed at the fundamental differences between the mycological constituents of transects I have made and the author's, as these were in areas not that distant from one another in Cameroon. However, explanations are offered for this and the fall off in mycodiversity between woodland areas, arable ones, etc.

The physical, climatic, and anthropogenic factors of the area are covered adequately, and the historical account of earlier collecting in Cameroon is an excellent distillate, appealing to a wider audience. I do, however, seriously wonder whether the taxonomic part should have been published separately from the details on collecting, monitoring, assessing mycodiversity, gathering meaningful ethnomycological data, and applying statistically sound techniques for analysis, as these include groups other than the non-gilled forms. Those accounts would be extremely valuable brought together as a separate publication as they would be of benefit to anyone collecting in the tropics, and not just Africa. Indeed, they should be read by all venturing into these parts of the world wishing to carry out mycological work. Perhaps this could be produced as part of the proposed extended project.

This is a well-documented publication worthy of the efforts of a well-seasoned mycologist, let alone just the subject of a thesis. 700 samples were analysed, 70 % basidiomycetes and 21 % ascomycetes. The time spent over all aspects covered must have meant the author spending many, many hours of the day collecting, identifying, and mulling over the finds. It was truly a labour of love – in all, 271 different fungi covering all groups were identified.

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Smut fungi of the Indian subcontinent. By Kálmán Vánky. 2007. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland (e-mail: ed-office@ib-pan.krakow.pl). Pp. 1-265, figs 86. [Polish botanical studies, vol. 26.] ISBN 978-83-89648-59-4. Price 48 €.

The smut fungi of the Indian Subcontinent (including Pakistan, Nepal, Bangladesh, India, and Sri Lanka) are represented in this book by 369 species belonging to 45 genera. The main body of the book consists of genera and species descriptions. A key to the genera, and keys to the species within each genus are compiled, and a host plant/ smut fungus index is given to

facilitate the identification of these species. Each genus is illustrated by a selected, representative species, with a drawing of its habit and SEM and/or LM photomicrographs of the spores. Each species description includes nomenclatural data, information about morphology of the sori, microscopic features of the spores, including wall ornamentation as seen by LM and SEM, germination of the spores (where there is information), general distribution, and known hosts from the Indian Subcontinent. Finally, there are a list of references on the literature on the Indian Subcontinent, and smut fungi and smut fungus/ host plant indexes.

I have a few remarks. *Sphacelotheca himalensis* is included as a member of *Microbotryum*, although this species possesses sori covered by a peridium and with a central columella, and spores initially connected by disjunctors. Vánky still accepts *Microbotryum* in a broad sense, but Denchev et al. (2006) have reduced *Microbotryum* to include only anthericolous species (incl. *M. majus* and *M. savilei*) on *Caryophyllaceae*, and I prefer to treat this genus in a narrow sense. In many species descriptions, the author repeats his measurements from previous studies of the respective species from Europe (e.g. Vánky 1994) or from type studies of species not described from the Indian Subcontinent. In all cases of descriptions, when spore measurements of specimens from the Indian Subcontinent were not made, the author had to reference a previously published source. It is a pity that the known hosts from this area are just listed without information about their exact localities.

This monograph will, however, be very useful and help all mycologists and plant pathologists studying this interesting group of parasitic fungi in the Indian Subcontinent.

Denchev CM, Moore RT, & Shin HD (2006) A reappraisal of the genus *Bauhinus*. (*Microbotraceae*). Mycologia Balcanica 3: 71-75.

Vánky K (1994) European smut fungi. Gustav Fischer Verlag, Stuttgart.

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Fungi of Australia: the smut fungi. By Kálmán Vánky & Roger G. Shivas. 2008. Australian Biological Resources Study (ABRS), G.P.O. Box 787, Canberra, ACT 2601 Australia (e-mail: sales@publish.csiro.au). [Fungi of Australia Series.] Pp. i-viii + 1-267, plates 1. ISBN 978-0-643-09536-6 [+ CD by Roger G. Shivas, Dean Beasley & Kálmán Vánky; containing 1108 black and white or colour figures and 295 distribution maps in colour; ISBN 978-0-643-09537-3.] Price AU$ 130.

The long-term and excellent collaborative research between Kálmán Vánky and Roger Shivas has included numerous collecting trips in Australia, and has yielded many new records of smut fungi for the continent, the description of

new species and genera, and now a monograph of the smut fungi of Australia as a new number of the series Fungi of Australia.

The monograph includes 296 species in 43 genera. About half of these species and six of the genera, *Anomalomyces, Centrolepidosporium, Farysporium, Fulvisporium, Pseudotracya,* and *Websdanea,* are endemic. While the three largest genera, *Sporisorium* (81 spp.), *Tilletia* (34), and *Ustilago* (36), account for more than half of the Australian species, only eight genera are represented in Australia by more than ten species, and 21 genera are known only by a single species. Furthermore, although 32 flowering plant families, 179 genera, and 488 species are known to be infected by smut fungi in Australia, 64 % of the smut species are exclusively parasitic on grasses (*Poaceae*) and 16 % on sedges (*Cyperaceae*).

The introductory chapters provide historical data about the investigations of smut fungi in Australia and general information on the biology of this taxonomic group, valuable for both students and researchers.

The main body of the book consists of a key to the genera of smut fungi and descriptions of genera and species, including keys to the species of each particular genus if more than one species is found in Australia. Each genus and species description includes nomenclatural data, information on the development of the sori and their morphology, microscopic features of the spores and sterile cells (if any), including wall ornamentation as seen by LM and SEM, germination of the spores (if there is information), distribution in Australia and in the world (if the genus/species is not endemic), and plant hosts in Australia. The detailed information about the known hosts, fungus distribution in Australia, and the specimens examined is noteworthy.

A list of doubtful and excluded names is also given. Finally, there are a list of host plants and their associated smut fungi, an appendix with new lectotypifications of four species described from Australia, an appendix with a description of one new species (*Tilletia australiensis*), a list of references, and an index of scientific names of fungi.

The monograph is accompanied by a CD incorporating a Lucid™ Player. The CD provides interactive and dichotomous keys that allow the rapid and accurate identification of the species. The user has easy access to a comprehensive fact sheet about each of the species, which includes a description of disease symptoms and macroscopic and microscopic characters, a map showing distribution in Australia, line drawing(s) and/or scanned specimen(s), light micrograph, and scanning electron micrograph. The CD contains 1108 black and white or colour figures, and 295 distribution maps in colour. The drawings, LM and SEM photomicrographs, distribution maps, are all of high quality and successfully complement the descriptions. The user can browse information by species and generic name of the fungus, or by genus name of the host plant

(through a host index), and can also view supplementary information, which includes a glossary and list of references.

The book and CD provide important information about our current knowledge of Australian smut fungi, and will help all mycologists, phytopathologists, and students interested in this parasitic group of fungi. The information is excellently presented and illustrated, and for anyone who wants to touch the beauty of the smut fungi, I would recommend that they just open the CD of the Australian smut fungi and enjoy.

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Ascomycetes

Now that an increasing number of works are thankfully considering fungi producing ascomata or basidiomata along with their conidial states, in the future all publications dealing with conidial fungi will be treated either here or under "Basidiomycetes" as appropriate.

The genus *Cladosporium* and similar dematiaceous hyphomycetes. Edited by Pedro W. Crous, Uwe Braun, Konstanze Schubert & Johannes Z. Groenwald. 2007. CBS Fungal Biodiversity Centre, P.O. Box 85167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl). Pp. viii + 256, figs numerous. [Studies in mycology no. 58.] ISBN 978-90-70351-61-0. Price 65 €.

This remarkable achievement of integrated modern systematic mycology, stunningly illustrated by colour DIC optics photomicrographs, SEMs, half-tones, and line drawings, is dedicated to the late Gerard de Vries (1919-2005), an outstanding CBS mycologist with a broad range of interests, who made the first in-depth attempt to understand species concepts in *Cladosporium* in the broad sense as far back as 1952. It comprises nine articles, involving 21 authors, and represents the cutting-edge of an integrated approach to the molecular and morphological systematics of *Cladosporium* and similar fungi — along with their sexual stages where known.

Crous et al. (pp. 1-32), using new information from LSU sequences, show that *Mycosphaerella*, which has been linked to over 30 genera of conidial fungi, is incredibly polyphyletic and includes species that can be distributed through five families: *Capnodiaceae*, *Davidiellaceae*, *Mycosphaerellaceae*, *Schizothyriaceae*, and *Teratosphaeriaceae* fam.nov. *Teratosphaeria* is separated primarily by the superficial stroma that links the perithecioid ascomata, and 32 species are combined into it for the first time; it has links with 12 conidial genera. Keys to the genera are presented, and in the case of anamorphs, also keys to the species

(e.g. of *Penidella*). Notes on some similar genera for which sequences could not be obtained are included, such as the lichenicolous *Stigmidium* of which fine photomicrographs of the type species are provided.

Crous et al. (pp. 33-56) consider the delimitation of *Cladosporium* from other genera, emphasizing the coronate conidial scars and teleomorphs in *Davidiella*. Other fungi placed in the genus are dispersed through a wide range of orders, including *Capnodiales*, *Helotiales*, and *Pleosporales*. The number of similar genera recognized here is 46, to which a key is thankfully provided and is surely destined to be intensively used.

Arzanio et al. (pp. 57-94) concentrate on *Ramichloridium* and allied genera, including *Periconiella*, *Rhinocladiella*, and *Veronaea*. ITS and 28S sequence data revealed eight clusters dispersed through *Capnodiales*, *Chaetothyriales*, and *Pleosporales*. A key is provided to 11 similar genera, of which five are newly described. I was interested to see that *Zasmidium* was retailed for the "cellar fungus" rather than *Rhinocladiella*, and that this clustered with some *Ramichloridium* species although morphologically closer to *Stenella*.

Schubert et al. (pp. 95-104) find that the fungus causing Cladosporium leaf blotch of *Paeonia* species, previously called *Cladosporium chlorocephalum*, has to placed in a new genus they name *Diplocladosporum* but which nevertheless still belongs in *Davidiellaceae*.

Schubert et al. (pp. 105-156), in what will surely be the most anxiously sought contribution by applied mycologists and pathologists in the set, tackle the *Cladosporium herbarum* complex. Sixteen species are accepted and a key to these is provided. Ten of the 16 are new to science, including four from hypersaline environments, one from an Antarctic *Caloplaca* species, and another causing a disease on *Iris* in New Zealand. Most isolates from human infections are found to belong to *C. bruhnei*. Five species have *Davidiella* teleomorphs, of which two are newly described and named. The complex has low molecular distances between species, and a high degree of clonal or inbreeding diversity, but most are distinguishable by conidial characters – especially spore width. An exception is *C. subtilissimum*, newly described from grapes in the USA.

Zalar et al. (pp. 157-183) focus on the ubiquitous *C. sphaerospermum*, where nine species are recognized and keyed, seven of which are described as new from hypersaline environments of which the complex seems to be characteristic.

Crous et al. (pp. 185-217) consider the opportunistic human pathogenic species in *Herpotrichiellaceae*, and show that *Cladophialophora* is distinct from *Pseudocladosporium*. However, the latter proves to be a synonym of *Fusicladium*, teleomorphs of which belong in *Venturia* of *Venturiaceae*.

De Hoog et al. (pp. 219-234) address the *Cladophialophora carrionii* complex, the causal agents of chromoblastomycosis in humans in arid regions, but which is also known from cacti. The new species *C. yegresii* is described from leaves of

the cactus *Stenocereus griseus*, but remarkably it is less virulent to the plant than are clinical isolates of *C. carrionii*.

Seifert et al. (pp. 235-245) uncover horrendous fundamental problems in the nomenclature of the anamorph of the creosote fungus, *Amorphotheca resinae*. It emerges that the same basionym has come to be used for the anamorph of that species in *Hormoconis*, as well as in the name of the mononematous morph of the resin fungus *Hormodendrum resinae* – a synnematous synanamorph of *Sorocybe resinae*. In order to enable the generic name *Hormoconis* to be retained for the anamorph of the creosote fungus, conservation of the name *Hormodendrum resinae* with a different type is recommended.

This is a pinnacle of achievement for the CBS mycologists and their collaborators. It demonstrates just what can be achieved in making sense of what to most mycologists is an "impossible" genus by combining molecular studies with critical microscopical observations, attention to nomenclatural details, and examining huge numbers of isolates and specimens – and then delivering a result for users in the keys and superb illustrations. The taxonomy of *Cladosporium*-like fungi has been raised to a new level, and all involved in the volume deserve to be heartily congratulated on this major achievement.

***Aspergillus* Systematics in the Genomic Era.** Edited by Robert A. Samson & János Varga. 2007. CBS Fungal Biodiversity Centre, P.O. Box 85167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl). Pp. vii + 206, figs numerous. [Studies in mycology no. 59.] ISBN 978-90-70351-69-4. Price 65 €.

Aspergillus systematics is at the forefront of the integration of molecular data, with the genomes of a remarkable nine species now or shortly to become available. There has also been a remarkable degree of international collaboration on the systematics of this genus, and *Penicillium*, fostered by the series of workshops initiated by Rob Samson and John Pitt in 1985. This volume is the output of an eponymous workshop held on 12-14 April 2007, which had 39 participants, and comprises 14 papers.

Geiser et al. (pp. 1-10) review the present state of species recognition and identification, and give the salutary warning that: "There is no one method (morphological, physiological or molecular) that works flawlessly in recognizing species" (p. 3). Ascospore wall characters are questioned, in some cases "multilocus DNA analysis showed that the assignments of anamorph-teleomorph connections were incorrect" (p. 4), and bar-coding using the ITS region and cox1 (which has numerous introns) does not seem possible, from a trial study of 45 *A. niger* isolates. Rokas et al. (pp. 11-17) consider comparative genomics and species concepts and report that four core studies reveal "significant variation in the nature of species boundaries across *Aspergillus*" (p. 11). With respect to sexuality and vegetative compatibility genes, Pál et al.. (pp.

19-30) examine the genes involved in sex and compatibility; *Het* genes regulate the formation of anastomoses and heterokaryons, and where heterokaryons are not tolerated, growth is inhibited leading to cell death. In reviewing the success of secondary metabolite profiling, Frisvad et al. (pp. 31-37) caution that using any one approach could yield misleading results, and they commend a consensus polyphasic approach to taxonomy using examples from *Aspergillus* sect. *Nigri*.

Balejee et al. (pp. 39-45) make recommendations for identifications in a clinical setting against the background of ITS sequences or morphology not being able to certainly identify species within sections; they commend the usage of, for example, the "*A. fumigatus* complex." That there is a major problem in that complex is evident from the contribution by Klaasen & Osherov (pp. 47-51) on strain typing in the genomic era; 16 strains could be discriminated by AFLP's, and variations in the sizes of tandem repeats were possible. Perrone et al. (pp. 53-66) address species in agricultural products; ochratoxin producers on grapes and coffee comprise no less than nine species, including three from grapes and four from coffee that are described as new here.

Pitt & Samson (pp. 56-70) consider the weeping sore of anamorph/teleomorph nomenclature, and discuss historical approaches. They argue for the retention of the dual nomenclatural system, and present an eight-point protocol for the description of new taxa. However, there is an unfortunate misunderstanding of the *Code* as it currently stands when they claim "many industrial users . . . are now familiar with the fact that a teleomorph name on a fungus means ascospores" (p. 69). This is a misconception that is potentially extremely misleading. A teleomorph name is the one to be applied to the holomorph, the fungus in all its forms, and not only that with ascospores! Where a teleomorph is known, that name can also be used for the anamorph as it is part of the same holomorph; for example, *Emericella nidulans* can be used for *Aspergillus nidulans* strains not producing ascospores – fortunately most fungal geneticists are pragmatic and just use *A. nidulans* regardless of what type of spores are being formed to avoid confusion in the literature.

Recommendations of an international panel on species concepts that was convened during the workshop are presented by Samson et al. (pp. 71-73). The panel: (1) considered a polyphasic approach the gold standard; (2) wished to retain the dual system of nomenclature, recognizing the difficulties in changing this; "The majority of the workshop saw the need for a separate fungal nomenclatural code such as the code the bacteriologists use" (p. 72) [– an issue destined to be hotly debated at the 9th International Mycological Congress in Edinburgh next year]; (3) recommended that cultures from the types of newly described species be deposited in 2-3 different open sources; and (4) proposed there should be a simple database for identification and considered its possible content.

The remaining five contributions all consider the taxonomy of different sections of the genus, generally using polyphasic and molecular phylogenetic approaches, and including keys. Varga et al. (pp. 75-88) on sect. *Candida* recognize it as having four species. In sect. *Clavati*, Varga et al. (pp. 89-106) distinguish six species. Sect. *Usti* is found by Houbraken et al. (pp. 107-128) to comprise eight species, one newly described. Sect. *Niger* is examined by Samson et al. (pp. 129-145) who overview identification methods and accept nine species. The final and largest contribution is on sect. *Fumigatus* by Samson et al. (pp. 147-204), which is considered to comprise 33 species, of which 23 have *Neosartorya* teleomorphs, with four species newly described. These last contributions are particularly stunningly illustrated by a combination of DIC photomicrographs and SEM micrographs, with coloured photographs of colonies and some other features.

The publication has clearly been most thoughtfully constructed and edited, and shows what heights can be reached through the collaboration of specialists. It is a model for how progress can be made in unraveling species-rich fungal genera, but requires mycologists of John Pitt and Rob Samson's caliber who have such long-sighted vision.

Indian sarcoscyphaceous fungi. By D. C. Pant & Vindeshwari Prasad. 2008. Scientific Publishers (India), P.O. Box 91, Jodhpur 342 001 (Raj), India (email: info@scientificpub.com). Pp. v + 124. ISBN 978-81-7233-525-0. Price 675 INR.

This slim, well-bound volume, dedicated to Vijai P. Tewari, an emeritus professor of Banaras Hindu University, is based on the detailed morphological study of 78 specimens mainly collected in the Himalayan hills, foothills, and plains, and 20 type or authentic specimens from foreign herbaria. (Two of these are not included, as the genus *Acervus* is now treated in *Pyronemataceae.*) The first 24 pages are devoted to an introduction, an extensive historical review of the taxonomy of discomycetes, mainly *Pezizales,* materials and methods, and a chapter on general morphology (and anatomy). Seventy-seven pages comprise the chapter "Description of Genera and Species." Eleven genera are recognized in the suborder *Saracoscyphineae.* The book title suggests that only the family *Sarcoscyphaceae* is covered, whereas two families, *Sarcoscyphaceae* and *Sarcosomataceae* are accepted, divided into five tribes, *Sarcoscypheae, Boedijnopezizeae, Pithyeae, Galielleae,* and *Sarcosomateae.*

Oddly, no keys to the genera or to the species within each genus are provided. Since an index to the scientific names is also missing, and the genera are treated in an unexplained order (that of a table on p. 104), it is rather difficult to locate any genus or species within the book, except by thumbing through it. The 11 accepted genera are *Sarcoscypha, Phillipsia, Nanoscypha, Wynnea, Cookeina, Microstoma, Pithya, Thindia, Galiella, Plectania,* and *Korfiella.* The

last mentioned genus is, in my opinion, probably a synonym of *Plectania*. The authors agree with my concept of *Plectania* in treating the spherical-spored *Pseudoplectania* as a synonym. Almost all species are illustrated, most by many photographs, nine species partly in transmission electron microscopy, and (sometimes very good, sometimes crude) line drawings. Some of the illustrations do not agree with the descriptions, e.g. *Thindia cupressi* is reported to have thick-walled hairs, but is illustrated with a line drawing of a thin-walled hair. For each species a relatively complete synonymy is presented. There is also an extensive bibliography of literature cited.

The authors appear to have somewhat bizarre nomenclatural concepts. In their discussion of the genus *Microstoma* they state: "Korf (1959) transferred *Plectania floccosa* to the genus *Microstoma*. Raitviir (1965) transferred *Sarcoscypha floccosa* (Schw.) Sacc. to the genus *Microstoma* as *M. floccosum* (Schw.) Raitviir." The Korf (1959) reference is to unpublished mimeographed lecture supplements I prepared for my students, and I could not have made any valid transfer there. Moreover, both Raitviir and I would have been transferring a species name, *Peziza floccosa* Schwein., not a later combination.

The treatment of *Cookeina*, in particular, is sketchy and clearly not up-to-date. They describe only two species, *C. sulcipes* [shown by Dennis (1994) and by Iturriaga & Pfister (2006) to have *C. speciosa* as its correct name] and *C. colensoi*. In addition, they note that three other species are reported from India, *C. tricholoma, C. indica,* and *C. mundkurii,* which they did not study. They merely report that "Their description and illustrations, however, are excellent and adequate for identification." Iturriaga and Pfister (loc. cit.) have synonymized *C. mundkurii* with the older *C. indica*."

Despite its many failings, this book does record valuable information on the species studied, and many of the illustrations are truly informative. Happily, there are relatively few typographical errors. It will surely be consulted by specialists for many years to come, all of whom are as likely as I was to be disturbed by some of its shortcomings. I regret I cannot advise individuals to purchase this work, though major libraries will need to add it to their holdings.

Dennis RWG (1994) Plumier's discomycetes. MYCOTAXON **51**: 237-239.

Iturriaga T, Pfister DH (2006) A monograph of the genus *Cookeina (Ascomycota, Pezizales, Sarcoscyphaceae)*. MYCOTAXON **95**: 137-180.

Korf RP, in Fitzpatrick HM & Korf RP (1959) LECTURES ON MYCOLOGY, *ASCOMYCETES*. Plant Pathology Department, Cornell University, Ithaca, NY. [Mimeographed.]

Raitviir A (1965) *Sarcoscyphaceae* in the Far East. [In Russian.] PROCEEDINGS OF THE ESTONIAN ACADEMY OF SCIENCES, BIOLOGY **14**: 529-535.

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Aggiornamento sul genere *Chaetomium* con descrizione di alcune specie coprofile, nuove per l'Italia and **A bibliography of *Podospora* and *Shizothecium*, a key to the species, and a description of *Podospora dasypogon* newly recorded from Italy.** By Franceso Doveri. 2008. Associazione Micologica Bresadola, Cenro Studi Micologici, P.O. Box 292, I-36100 Vicenza, Italy (e-mail: amb@ambbresadola.it). Pp. 160, col. figs 74. [Pagine di Micologia, Numero Speciale no. 29.] ISSN 1122-8911. Price 20 €.

In the covering letter sent to me with this booklet, dated 5 June 2008, Franceso Doveri remarked: "These updates must be regarded as the ideal continuance of my monograph Fungi fimicoli Italici" (Doveri 2004; reviewed in Mycotaxon 90(1): 220-221, July-September 2004). I concur, but they will also be valuable in their own right for those endeavouring to determine collections of the three genera considered.

Chaetomium occupies the first 60 pages, and deals with six species new to Italy, provides updates on others, has a key to the Italian species, and then a key to the 104 known species (including those of *Farrowia*). Original diagnoses of the species new to Italy are provided, with descriptions based on Italian material, and often extensive observations. The keys, descriptions, and observations are given in both English and Italian. Twenty-two species are illustrated in composite plates, all but one comprising superb colour photomicrographs. These often have shots of single perithecia, and show details of their wall structures: those of the cephalothecoid plates in *C. trignosporum* are especially striking (Fig. 22) and were not apparent at all in the SEM micrographs in von Arx et al. (1986: fig. 84) – the SEM does, however, reveal detail of the sometimes characteristic ornamentation on the hairs themselves (Hawksworth & Wells 1973) which is hardly seen by light microscopy.

However, it is the 100-page treatment of *Podospora* and *Schizothecium* that will be especially appreciated internationally, as, after four pages of introduction and description of *P. dasypogon,* the world species of both genera are listed together, alphabetically by species epithet, with places of publication and synonyms. Here I was pleased to see the familiar name *P. anserina* retained over the hardly mentioned *P. pauciseta*; the species epithets date from 1865 and 1852, respectively, and the matter needs to be the subject of a formal proposal for conservation as has been previously pointed out elsewhere (Hawksworth 1994). The number of species accepted is 114, of which 31 occur in Italy. In the case of the Italian species, specimens examined since the 2004 monograph are detailed. Below all the species entries, key references are given by referring to numerals allotted to them in the 213 title bibliography. As in the case of the section on *Chaetomium*, there are again superb colour composite plates which treat 26 species, in some cases with two full-pages of pictures, and including stunning DIC shots of the caudae on the ascospores, as well of asci, perithecial

walls, their setae, etc. Those of the caudae to some extent complement those in Lundqvist (1972), which revealed the gelatinous apparatus of these fungi so splendidly using Indian ink in particular.

As the monograph (Doveri 2004) illustrated microscopic features only by line drawings, supplemented by colour plates only of the macroscopic features of a representative selection of species, this is truly a work to kept by its side. Franceso is to be congratulated on the completion of yet another major work that is sure to receive intensive use.

Arx, JA von, Guarro J & Figueras MJ (1986) The ascomycete genus *Chaetomium*. Beihefte zur Nova Hedwigia 84: 1-162.

Doveri F (2004) Fungi fimicoli Italici. Associazione Micologica Bresdaola, Trento.

Hawksworth DL (1994) Constraints to pest characterization caused by biological nomenclature. In The identification and characterization of pest organisms (Hawksworth DL, ed.): 93-105. CAB International, Wallingford.

Hawksworth DL & Wells H (1973) Ornamentation on the terminal hairs of *Chaetomium* and some allied genera. Mycological papers 134: 1-24.

Lundqvist N (1962) Nordic *Sordariaceae* s. lat. Symbolae Botanicae Upsalienses 20(1): 1-374.

Mikokalitaievbie gribyi (poryadok *Mycocaliciales* Holarktiki [Mycocalicioid fungi (the order *Mycocaliciales*) of the Holarctic]. By Alex N. Titov. 2006. KMK Scientific Press. Moscow, Russia. Pp. 296, figs 26, col. figs 113, figs 26, tables 5. ISBN 5-87317-344-3. Price not indicated.

Mycocaliciales primarily comprise saprobic, fungicolous, and lichenicolous fungi, with stalked ascomata, which generally form a mazaedium. A few species have been considered lichenized, but often these are ones with uncertain biologies. These fungi were formerly included amongst *Caliciales*, and consequently studied by only lichenologists, even though they could hardly be considered lichen-forming. This is the most comprehensive work on these fungi to date, as while the focus is the holarctic region, keys to all known species are included: *Chaenothecopsis* (65 spp. in the world, 58 spp. in the holarctic), *Mycocalicium* (13, 8), *Phaeocalicium* (20, 18), *Protocalicium* (1, 1), *Pyrgidium* (1, 1), *Sphinctrina* (7, 7), and *Stenocybe* (9, 8). The total number of species in the holarctic treated is 102, of which nine are described as new. For all accepted species, there are detailed descriptions and synonymies, details of types, discussions, and information on specimens examined. There are also notes on 26 excluded species. But this is not just a bare taxonomic treatment. The first part of the book devotes a massive 93 pages to the history of their classification, characters (including anamorphs), ecology (with tables showing host trees), distribution (with 26 maps), and SEM micrographs of the ascomata and especially ascospores of selected species. This is an outstanding work, and

even though it is entirely in Russian, I found the keys could be worked with knowledge of a few words and a dictionary. Sadly, it is also a memorial to the author, who died last year. He was clearly a most able and diligent mycologist whose full potential unfortunately could not be realized.

Microfungi occurring on *Proteaceae* in the Fynbos. By Seonju Marincowitz, Pedro W. Crous, Johannes Z. Groenwald & Michael J.Wingfield. 2008. CBS Fungal Biodiversity Centre, P.O. Box 85167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl). Pp. vi + 166, figs 88, tables 6. [CBS fungal biodiversity series no. 7.] ISBN 978-90-70351-71-7. Price 50 €.

Visiting the fynbos shrublands of South Africa in 2005, was to me like imagining seeing life on another planet – and amongst the most spectacular plants there are the *Proteaceae*. As might be forecast, this vegetation type supports a vast array of unique microfungi, and this study is a major step towards getting to grips with that diversity. Litter bags were collected, fungi cultured, and where possible sequenced. Considering that this study is based on just two years' sampling of 29 species and subspecies of but four genera of *Proteaceae*, all in Western Cape Province, it is remarkable how many unusual fungi were discovered. Indeed, "every 2.2 collections represented a different fungal species" (p. 147). In all, 141 species were found, including two genera (*Coniozyma* and *Multisporascus*) and 59 species new to science, 38 species new to South Africa, and 48 new reports on *Proteaceae*. However, although the collections were made only in 2000-2001, this output took eight years to achieve. That 43 % of the total species were new to science and apparently host-specific is of especial interest to those concerned with estimates of fungal diversity on plants. The species are presented alphabetically, with detailed descriptions and discussions, and accompanied by superb coloured photomicrographs. The final sections of the book are concerned with discussions of the diversity of microfungi in the fynbos, their systematic positions, ecology, and succession. The authors "regard the outcome of this study as only representing the tip of the proverbial iceberg" (p. 148) of fungi associated with *Proteaceae*, which has to be the case as this study was admittedly based on limited collecting of only microfungi in a restricted region. It is gratifying that such an in-depth study of the identity of such primarily saprobic fungi could be funded in South Africa, as a similar project on a particular group of plants would be unlikely to be supported in Europe or North America – and if it was would be unlikely to find a publisher. However, as the results show how much novelty can be revealed as a result of intensive collecting and critical study, this will be a useful work to use as leverage in other grant applications.

Lichen-forming fungi

Index nominum lichenum inter annos 1932 et 1960 divulgatorum. By Ivan Mackenzie Lamb. 1963 [Reprint 2004]. Singh Mahendra Palsingh, Dehra Dun, India. [Available from Koeltz Scientific Books, PO Box 1360, D-61453 Königstein, Germany.] Pp. xiii + 809. ISBN 81-211-0566-8. Price 120 €, US$ 185.

Entrusted by the Section Lichenology of the VIII International Botanical Congress in Paris in 1954, the English lichenologist Ivan Mackenzie Lamb (1911-1990), who had then moved via Argentina to North America, worked for a decade on the compilation of an index to lichen names. The work was intended as the natural, indispensable continuation of the monumental Catalogus lichenum universalis by Zahlbruckner (1921-1940). Initially referred to as "Codex lichenum," the work was published by Lamb in 1963 as Index nominum lichenum. The Index lists, in alphabetical order, all taxa of the rank of genus and downwards, and combinations and new names, of lichens which were published subsequently to, and were not included in, Zahlbruckner's volume IX (1934), up to 1960. Furthermore, the Index also contains names that had already appeared in Zahlbruckner's volume X (as they were not enumerated alphabetically), and other the names omitted or overlooked by Zahlbruckner by mistake, and which did not appear in the other important nomenclatural compilation then available, the synonym index of Vainio's Monographia Cladoniarum universalis (1887-1897).

For those pre-computer days, the data gathered by Lamb are really astonishing: altogether, he listed 415 genera, 8205 species, and 6789 infraspecific taxa, a total of 15 409 taxa, with the corresponding full citations. He listed the first reference to new names, reproduced exactly as proposed by their authors, and synonyms, when necessary, with proper citations to the author who proposed the synonymisation (i.e. it was not simply Lamb's "expert assessment"). In the case of new combinations, the basionym was given in the form recognised in Zahlbruckner's Catalogus which was cross-referenced. An important novelty, which added further value to the work, was that he listed names of lichenicolous fungi included in "lichen" genera, when those studying this peculiar group of organisms were relatively few, and the literature particularly difficult to trace. Furthermore, Lamb was compelled to deal with the works of the Italians Ciferri & Tomaselli, who are still mentioned amongst the lichenological community as "those people who published the highest number of illegitimate names in the taxonomic literatures of all times."

The Index deeply reflects the man who compiled it, a highly honest, non-authoritative but absolutely talented researcher well conscious of the importance

of Linnaeus' motto "*Nomina si nescis perit et cognitio rerum.*" He humbly spent many years (actually, six more than originally planned) to gather, check and critically note a breath-taking amount of taxonomic literature, which arrived on Lamb's desk at the Farlow Herbarium, Harvard University, also due to the disinterested co-operation of a number of fellow colleagues worldwide ("none mentioned, none forgotten," as he wrote in the short preface to the work). When it appeared, the Index did not receive as much reception and recognition as it deserved, and still deserves. Interestingly, this magnum opus was ignored in one of the two obituaries that appeared after his death to commemorate Lamb's scientific achievements, and was simply cited, but not commented upon, in the other. This probably was due to the work having no pretensions to be taxonomically authoritative, and he did not propose or adopt any taxonomic scheme (as had Zahlbruckner in his Catalogus), and nor did he introduce nomenclatural changes. However, it is certain that Lamb's Index still exceeds all the (very few) name compilations for lichen fungi to have appeared so far for precision, accuracy and dedication.

In the era of databanks online, one could ask why he or she should buy this book, if not already available in the departmental library. Most of the information concerning the names present in the Index is now retrievable on the web, as the informational content has been progressively absorbed by regional or national checklists and databanks. However, most of these instruments do not give the complete references, or they are not immediately available, as the Index does, and *in toto*, with full reliability. An exception is names in the Index Fungorum database, which are now directly linked to copies of the pertinent page in Lamb's Index. But to have it on your desk, or near to it, gives a very positive feeling: information is immediately at your hand, and absolutely verifiable, if you can just retrieve one of the thousands rare, inaccessible journals that Lamb had the determination to track down, and to check. The metaphor of Bernard of Chartres, "we are dwarfs on the shoulders of giants" (John of Salisbury, Metalogicon III, 4) sounds more than pertinent ...

The publishers should be complimented for deciding to issue again this Index, especially as it is now very difficult to find an original copy in virtually any antiquarian bookshop. The volume is well printed on high quality, glossy paper, and the cost is relatively low for the amount of information it contains. All lichenologists and other mycologists interested in nomenclature should have a copy in their library.

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Lichen distribution maps: a world index and bibliography. By Peter Scholz. 2007. Thüringische Botanische Gesellschaft e.V., Herbarium Haussknecht, Friedrich-Schiller Universtät Jena, Fürstengraben 1, D-07737, Jena, Germany (e-mail: hmtz@umi-jena.de). Pp. 179. [Haussknechtia Beiheft no. 14.] ISBN not indicated. Price 19.90 €.

This long-expected painstaking compilation, which started over 20 years ago, attempts to include all published distribution maps of lichens and lichenicolous fungi, and represents maps abstracted form 2283 literature sources, the first dating from 1836. The species are listed alphabetically, and the references to maps are in the novel form "B 44" which indicates the 44th paper with an author whose surname starts with "B" listed in the massive 124 page small-type bibliography. There are too many taxa listed to count! Under each bibliographic reference is a note on the number of maps, their scope, and type – and the species covered if rather few. For example, "4 dot maps for bioindication in Luxembourg" under D 30, and "2 grid maps for *Lecanora conizaeoides* and *Lepraria incana* in Rostock (northern Germany)" under G 49." Peter, a teacher of mathematics, has been extremely thorough in tracking down, and searching out, elusive publications – as I know well from visits to my own lichenological library! No similar work ever seems to have been attempted for lichens and lichenicolous fungi, and this is clearly an essential reference work for all lichenological libraries.

Flora of New Zealand – Lichens. By David J. Galloway. 2007. 2nd edn. New Zealand Manaaki Whenua Press, Landcare Research, P.O. Box 40, Lincoln, New Zealand (e-mail: mwpress@landcareresearch.co.nz). Vols 2, pp. cxxx + 2261, col. plates 16. ISBN 10: 0-478-09376-4, 13: 987-0-09376-6. Price NZ $ 79.99.

David Galloway's original Flora of New Zealand – Lichens was a handsome and respected volume published in Wellington in 1985. We now have a second edition, completely rewritten, with many more species and with much greater detail. Now lichenicolous fungi are also included. Altogether there are 1706 taxa, which makes it comparable in scope to the British lichen biota of 1743species. Yet the New Zealand work is much more detailed and better printed than the Lichen flora of Great Britain and Ireland (Purvis et al. 1992), and is all the work of a single individual, in contrast to the large team of writers and editors who struggled for years to produce the British book.

The bulk of the New Zealand volumes consist of accounts of genera and species, alphabetically arranged. Under each genus the type species is listed, after which follows the description, where the reader is referred to the first edition in many instances. Therefore, this second edition should be used in conjunction with the first, and it is not a complete replacement. Following the description is a valuable detailed discussion of the history of the genus, together

with molecular work, which is now the "flavour of the month." At the end are bracketed keys to the species, all concise and of contrasting characters, which is how keys should be.

Under each species (regrettably not numbered) the place of publication is cited, together with any basionyms and synonyms, all with full references. However, the multiple authors on pp. 830 – 831 and 900 – 902 should have been reduced to "et al." in accordance with Rec. 46C. 2 of the Code.

Surprisingly, types are listed separately. Next illustrations are detailed, which include popular books like Dobson's (2000). A detailed description follows, then chemistry, including spot tests and lichen substances. Then there is a single word on world distribution (cosmopolitan, endemic, etc), after which are listed New Zealand localities and habitats, followed by the countries from which it has been recorded, together with references. Last of all comes the jizz. This arrangement should serve as a model for other similar works. The place of publication of names is especially valuable, and elsewhere is even omitted from major floras, such as Stace's New flora of the British Isles (Stace 1991). There are no new names or combinations made.

Taxonomy apart, there are interesting sections on recent lichenological exploration, collectors, authors, biogeography, glossary, etc, as well as 13 keys to genera and 16 excellent colour plates of species. A surprising omission from the numerous acknowledgements listed is the name of Peter W. James, who had David Galloway appointed to the Natural History Museum in London on 5 February 1973, and who recommended his promotion, encouraging his work on New Zealand lichens.

A special feature of the work is the numerous references. The bibliography covers 181 pages, but there are a few mistakes. For instance, on p. 235 under *Caloplaca* "Laundon 1992" is cited but the reference in the bibliography on p. 2095 refers to Laundon's 1992 Lichenologist paper on *Lepraria*, when in fact his account in the Lichen flora of Great Britain and Ireland is intended. There are also problems with the citation on p. 734 of the Ryan et al. reference of 2004b on pp. 2140 – 2141, where 2004b appears twice; is the Wirth 1995 reference on p. 383 1995a or 1995b (p. 2173)?; and to which, if any reference does Wolseley 2002 on p. 336 refer to on p. 2173?), etc. Perhaps David should have been more selective in his literature, then these problems may not have occurred.

A prominent asterisk (*) is used to denote both workers in New Zealand and lichenicolous fungi, yet this fact is not mentioned until p. 2195. The authors of *Caloplaca cerina*, the type species of *Caloplaca* (p. 208), are (Hedw.) Th.Fr., as given in the Botanical Journal of the Linnean Society **147:** 491 (2005). At the end of the book is an excellent glossary, the meaning of the terms clearly and concisely expressed: a model of its kind. Afterwards comes the index,

which would have been more valuable had the trivial names been placed in alphabetical order rather than under genera. Two maps of New Zealand appear at the very end.

The work deserves a wider audience than those concerned with New Zealand. Many lichens have a more extensive distribution than many organisms, and a few have been accidentally introduced. Of the taxa treated, some 367 taxa are cosmopolitan and 171 bipolar, soothe book should appeal to lichenologists worldwide. The two doorstopper volumes should have been divided between the O and P genera, rather than after *Pachyphiale*. Space on shelves should be made available in every lichenologist's library, and they are amazing value for money.

Dobson FS (2000) Lichens: an illustrated guide to the British and Irish species. 4th edn. Richmond Publishing, Slough.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds) (1992) The lichen flora of Great Britain and Ireland. Natural History Museum Publications, London.

Stace CA (1991) New flora of the British Isles. Cambridge University Press, Cambridge.

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Contributions towards a new systematics of the lichen family *Thelotremataceae*. By Andreas Frisch, Klaus Kalb & Martin Grube. 2006. J. Cramer in der Gebrüder Borntrager Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany (e-mail: mail@schweizerbart.de). Pp. 556, figs 159, plates 26, tables 9. [Bibliotheca lichenologica No. 92.] ISBN 978-3-443-58071-8. Price 88 €.

This volume is based on the PhD thesis of Andreas Frisch, which was carried out at the University of Regensburg under the supervision of Klaus Kalb. The work is divided into three distinct parts. The first is entitled "The lichen family *Thelotremataceae* in Africa" by Andreas alone. The revision is based on collections he made in 19 localities in Cameroon in January-April 1999, and in Tanzania in August-October 1999. Habitats sampled included mangroves, coastal forests, and the eastern mountains including Kilimanjaro. About 1300 collections were made, and in addition some 320 type and other specimens from different herbaria were studied. Ninety-four species are accepted, of which 17 are described as new, and 47 are first records for Africa. In parallel with the segregation of additional genera in *Graphidaceae* by Staiger (2002), 19 genera are now recognized, of which 12 are known in Africa, including two described in this part for the first time: *Acanthotrema* and *Fibrillithecis*. The characters used include apothecial types, structure of the phenocortex, columella types, and especially ascospore structure (e.g. amyloidity in the endospore). Some characters emphasized previously, such as the carbonization of the exciple, proved too variable as generic criteria. For the accepted species,

detailed descriptions are provided with full synonymies and details of types, information on ecology and distribution, and collections other than those from Africa studied are also listed. The whole is well illustrated by macrophotographs of the habit, and also photomicrographs and line drawings of apothecia sections, asci, and ascospores in many of the species. Appendices summarize the species known from different African countries and also the various collection sites.

The first part excludes taxa with complex columella structures, which are dealt with in the second part, co-authored by Klaus Kalb. This revises taxa worldwide with a reticulate or fissured hymenium. Some 650 specimens, including pertinent types, have been examined and 42 species are accepted dispersed through five genera, three of which are newly described (viz. *Gyrotrema*, *Melanotrema*, and *Redingeria*). The largest is *Stegobolus* (26 spp.), a resurrected generic name introduced by Montagne in 1845 and hardly used since. The other genera are much smaller: *Gyrotrema* has one species, *Melanotrema* six, *Ocellularia* four, and *Redingeria* five.

In the final part, the authors combine with Martin Grube to test the robustness of the new systematic proposed by molecular methods using material of 46 species representing 13 of the now recognized genera. There was a "fairly good congruence" (p. 518); *Fibrillithecis, Myriotrema*, and *Ocellularia* formed a monophyletic clade, and the rest of the genera a polyphyletic looser *Thelotrema* cluster. However, *Ampliotrema* was not supported, and the family concept is brought into question by two *Graphis* species clustering with the *Ocellularia* clade. It would be interesting to see the results of an analysis including larger numbers of species, and especially representatives of genera currently placed in *Graphidaceae*.

The contrast of the generic classification proposed here with the three-genera system (viz. *Myriotrema*, *Ocellularia*, and *Thelotrema*) adopted by Mason E. Hale in the early 1980s, can only be described as staggering. The systematics of the thelotrematoid fungi is raised to a new level by this major work, and the generic placement of many Asian and Neotropical species lacking complex columella structures will now have to be revisited. It is an outstanding achievement.

Staiger B (2002) Die Flechtenfamilie *Graphidaceae:* Studien in Richtung einer natürlichen Gleiederung. Bibliotheca lichenologia 85: 1-526.

The lichen family *Graphidaceae* in Australia. By Alan W.Archer. 2006. J. Cramer in der Gebrüder Borntrager Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany (e-mail: mail@schweizerbart.de). Pp. 191, figs 135, maps 1, tables 4. [Bibliotheca lichenologica No. 94.] ISBN 978-3-443-58073-5. Price 68 €.

This revision accepts 16 genera, 127 species, and two varieties. The largest genera are *Graphis* (54 spp.) and *Phaeographis* (19 spp.). Surprisingly, no new species are described, but there is a single new combination and ten names are

synonymized. In addition, 13 species are excluded for a variety of reasons. While it might at first seem surprising that no new species are included, this is has to be seen in the context of Alan Archer's work on the family in Australia since the late 1990s; new species discovered have been described earlier elsewhere. This is a traditional taxonomic treatment, with keys, descriptions, details of places of publication and types, and paragraphs on chemistry, distribution and ecology, selected specimens examined, and remarks. Most pertinent type specimens appear to have been checked from a wide range of herbaria, and while in some cases "*fide*" appears to indicate they have not, it would have been helpful to have indicated those actually studied more explicity. Chemistry is emphasized, not least in the keys, which is not going to facilitate their use by lichenologists without the necessary facilities for their detection. However, 43 % lack lichen compounds, and 44 % have either norstictic or stictic acid. The figures comprise half-tone habit images (six per page), but surprisingly for this family, there are no drawings or photographs of ascoma sections or exciple structures, and only one of ascospores (of nine species). I would also have welcomed more discussion and analysis of the ecology and distribution of the family in the country; that aspect is only accorded two-thirds of a page, but s surely one on which the author must have a wealth of knowledge from personal field experience. This work would have been at home in a volume of the lichen series in the Flora of Australia.

Lichenological contributions in honour of David Galloway. Edited by Ingvar Kärnefelt & Arne Thell. 2007. J. Cramer in der Gebrüder Borntrager Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany (e-mail: mail@schweizerbart.de). Pp. xiiii + 603, figs 225, tables 18. [Bibliotheca lichenologica No. 95.] ISBN 978-3-443-58074-2. Price 98 €.

This magnum opus includes 36 contributions from friends and colleagues of David Galloway, arranged in two parts. Part I is a compilation of seven historical accounts (117 pp altogether) and Part II, the bulk of this publication, includes 29 contributions to Southern Hemisphere and tropical lichenology, all arranged alphabetically by first author's name and preceded by a preface.

The first paper by Lars Arvidsson is a summary of David's long lichenological career which took him from his home in New Zealand to the UK in the 1970s, and from here to many other countries both in the North and Southern Hemispheres before going back to New Zealand in the mid-1990s. One of the fruits of this outstanding career is his prolific scientific contribution with over 300 hundred papers written in 40 years of work, which also include a major solo publication, the Flora of New Zealand – lichens, recently much extended and revised and no longer fitting into one volume (see above)! This paper and the editors' Preface also mention David as a devoted husband and

a most generous friend, something that many, including me, can corroborate from our knowledge of him. Of the 18 species named after him, 14 are newly described in the present volume. Arvidsson only includes 16 as he forgot to include *Cladonia gallowayi*, described from New Zealand in 2003, but listed in the on-line INDEX FUNGORUM and RECENT LITERATURE ON LICHENS; and *Dactylospora davidii* described as new in the present volume (pp 233-234).

The remaining historical contributions are a miscellaneous collection of papers, starting with David Hawksworth's paper on W. Lauder Lindsay's contribution to New Zealand's lichenicolous fungi, Mark Seaward's paper on Richard Spruce, Kärnefelt & Thell's accounts of Acharius and the early days of the International Association for Lichenology (IAL), Per Magnus Jørgensen's on Norwegian lichenology, and Roland Moberg's insight into Uppsala's herbarium visitor book. All of these papers have a strong link to David Galloway's background, interests, and pursuits. In fact, it was thanks to David's infectious enthusiasm and through his support for the IAL that many of us began to study tropical lichens. And, if I had not read Kärnefelt& Thell's account, probably I would not have realised that there had been so much going on in the IAL prior to David Galloway's presidency of the fourth council. Though some things have not changed much from the early days, as far back as 1977, Irwin Brodo (the penultimate President) was already expressing his concern regarding the financial situation of the Association, as the dues did not cover much beyond the cost of printing the newsletter. Also, despite an increased focus on Southern Hemisphere and tropical lichenology, the lichen researchers are still mostly from Northern countries (e.g. of about 56 contributors to this volume, only 12 are from the South).

The second part includes the taxonomic, floristic, and ecological contributions to this FESTSCHRIFT. In time, the contributions of this section might not be comparable in systematic relevance to that of Josef Poelt's homage of 1984, also referred to as the "900 page lichen bible," but it will certainly be much cited by researchers of tropical lichens after Galloway's (1991) edited volume on tropical lichens. The taxonomic and nomenclatural novelties in the text amount to: 45 new genera, species, and infraspecific taxa (all clearly illustrated with photographs and line drawings), and 26 new combinations. Most of the contributions, except for Thell and collaborators on the phylogeny of the Antarctic genus *Himantormia*, do not include molecular data, but are substantial taxonomic accounts which might include keys; e.g. Frödén and Kärnefelt on the genus *Teloschistes* in Africa, Hafellner & Mayrhofer's on lichenicolous fungi of New Zealand (these two the largest contributions to the text with ca 20 pages each), Hertel's paper on new records of lecideoid lichens from the Southern Hemisphere, Kalb's new taxonomic and nomenclatural novelties (pp. 297-316), and Kondratyuk and collaborators' 19 new species of

the genus *Caloplaca* in Australia. Unfortunately the authors of the latter do not provide a key for this highly diverse and difficult genus.

Also in this section there are three lichen community contributions by Lewis-Smith on the small Antarctic island of Signy (pp. 387-403), Wirth et al. on the lichens of the Central Namib Desert (pp. 555-582), and Wolseley et al. on the lichens of Malaysian dipterocarp forests (pp. 583-603), the latter being the continuation of a survey started by David Galloway in his final years of employment at the Natural History Museum. Biogeography, a subject that David Galloway championed for lichens, is included in the contributions by Hafellner & Mayrhofer mentioned earlier (pp. 257-258), in Quillot and collaborators (pp. 479-488) who compare the lichen of Antarctica and Chile, and Randlane & Saag (pp. 489-499) address the distribution patterns of cetrarioid lichens in the Southern Hemisphere.

As a whole the book is well written and illustrated and has few typographical errors, e.g. a missing caption on p. 441 for fig. 3G, and the IAL newsletter acronym changed from ILN to INL on p.87. The photographic reproduction quality has improved from earlier volumes of this series, and it now rivals those of more upmarket scientific publications. I found the price of the paperback also rather competitive and in line with publications of similar scope. This is certainly a nice memento for David, and an important contribution to the subject.

Galloway DJ (ed.) (1991) Tropical lichens: their systematics, conservation, and ecology [Systematics Association Special Volume, No. 43.] Clarendon Press, Oxford.

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Lichenologische Nebenstunden. Contributions to the lichen taxonomy and ecology in honour of Klaus Kalb. Edited by A. Frisch, U. Lange & B. Staiger. 2007. J. Cramer in der Gebrüder Borntrager Verlagsbuchhandlung, Johannesstrasse 3A, D-70176 Stuttgart, Germany (e-mail: mail@schweizerbart.de). Pp. 343, figs 110, tables 14. [Bibliotheca lichenologica No. 96.] ISBN 978-3-443-58075-9. Price 74 €.

This book has been edited by Klaus Kalb's students to honour him on his 65th birthday, and, like the previous volume in the series (see above), it is a tribute to his contribution to (mostly tropical) lichenology. It includes 27 papers, mainly on systematics and taxonomy, six of which discuss tropical collections. As before, the arrangement of the contributions is in alphabetical order by first author, preceded by a preface, and an introduction of Klaus Kalb's lichenological achievements by David Galloway. As the list of taxa described or recombined by Klaus is extraordinarily long, extending over ten pages, a separate paper is included at the end of this festschrift. Also in this paper we are made aware that lichenologists have been ready to appreciate his contribution earlier and

thus have dedicated to him a total of 32 taxa, including three new genera, of which only eight are introduced as new to science in the present volume.

Many of the authors contributing to the previous volume have also papers in this one, and the treatments follow similar layouts, with good descriptions and illustrations for the new taxa, and keys where appropriate. Nevertheless, a few more papers embrace the use of molecular data to support or discuss current systematic emplacements of the taxa, e.g. Bylin and collaborators' on the phylogenetic study of the *Fuscideaceae* (pp. 49-60), Lohtander et al.'s treatment of *Physconia* in Russia (pp. 175-184) which also describes two new species in the genus, and Nordin et al.'s (pp. 247-266) presentation of preliminary molecular data on 26 species of *Aspicilia* from Fennoscandia. This information is always compared with morphological and chemical variation. Although the majority of taxonomic and nomenclatural novelties in the text (42 and six respectively) are from lichenologically less explored regions and continue to support Aptroot's prediction that at least 50 % of tropical forest lichens remain undescribed, there is still work to be done in Europe. Thus the papers by Harrie Sipman (pp. 267-277) and Søchting, Huneck & Etayo (pp. 279-286) describe four and one new species respectively from Greece, Germany, and Spain.

Although Kalb's 89 research papers and input to the subject in the last 40 years might seem by comparison to that of Galloway's more 'modest', I would direct you to the last paragraph of Marcelli and collaborators' article on p. 225, where they not only dedicate this contribution to their teacher and friend, but show Klaus as a generous human being. I was very moved by their simple and effective way of saying thank you. I am sure he is very proud of them, and hope that his own contribution to the subject will not stop at 65!

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Corticolous crustose and microfoliose lichens of northeastern Brazil. By Marcela Eugenia da Silva Cáceres. 2007. IHW-Verlag, Postfach 1119, D-85378 Eching bei München, Germany (e-mail: dr.schmidt@ihwverlag.de). Pp. 168, figs 34 (ca 12 col.), tables 1. [Libri Botanici No. 22.] ISBN 978-3-930167-68-5. Price 27.90 €.

This report is based on a PhD carried out under the supervision of Gerhard Rambold (Universität Bayreuth), with assistance from Robert Lücking in particular, amongst others. Collections were made in 22 localities in the north-eastern coastal strip of Brazil, which includes parts of five states, in 2000-2002. The vegetation is a mixture of Atlantic forests and adjacent inland mediterranean-like Caatinga. Of 456 collections made, 426 were named; 383 to species, 25 tentatively to species, 18 only to genus, with 30 sterile crusts. Eighteen species are described as new, and 14 new combinations are made.

That so many new species were found in only 22 sites testifies to the extent of undiscovered lichen diversity in the region. Amongst the new species, is the first lichenized *Plectocarpon* discovered, *P. syncesioides* – making *Plectocarpon* yet another example of a genus with species that have crossed biological relationship boundaries. The number of genera treated is 114, and there is a key to these, and then separate keys to species under each generic entry. For each species the specimens studied are listed, and then, in some cases, notes are added. What is most appealing in the book are the stunning 12 pages of colour images, with eight species per page. These are all macroscopic, and include many lichens for which coloured images have not previously been published; photomicrographs and drawings of internal structures and ascospores are lacking. There is so little published on bark-inhabiting lichens in the neotropics, that this is an important milestone for the region, and one which will also facilitate the identification of the often neglected crustose species by ecologists as well as lichenologists. A most commendable piece of work.

Flechten Madeiras, der Kanaren und Azoren. By Felix Schumm. 2008. F. Schumm, Mozartstraße 9, D-73117 Wangen, Germany (e-mail: fschumm@online.de). Pp. iv + 294, col. figs. ISBN 978-3-00-023700-3. Price 40 €.

This privately printed book is a well-illustrated introduction to the lichens of the Azores, Canary Islands, and Madeira, with an emphasis on the macrolichens. Each of the 247 species treated has a whole page, half to two-thirds of which comprise photographs of the thalli, with close-ups of diagnostic features, and in some cases stained sections of ascomata or thalli, and ascospores. The format demands that there is little space for detailed descriptions, so these are brief, and sometimes in smaller type where space is especially critical, but they do include quite detailed information on the chemical compounds produced, and an indication of habitat and island groups on which they occur. In addition to being a valuable guide for lichenological visitors, the book is of wider interest in containing the first coloured images of several species known only from the islands, such as *Cladonia macaronesica, Hypogymnia madeirensis, Ramalina madeirensis*, *Roccella canariensis,* and *Xanthoparmelia madeirensis*. There are also keys provided to all species of selected genera in the islands, which are especially species rich, including *Heterodermia* (12 spp.), *Hypotrachyna* (12 spp.), *Punctelia* (10), *Roccella* (15), and *Xanthoparmelia* (11). The author is a skilled amateur, and this production has clearly been undertaken because of his deep affection for lichens in the Atlantic islands.

Lichenológia – a zuzmók tudománya. By Edit Farkas. 2007. MTA Ökológiai és Botanikai Kutatóintézete, Alkotmány u. 2-4, 2163 Vácrátót, Hungary. Pp. 193, figs 48 (some col.), tables 12. ISBN 978-963-8391-38-4. Price 2000 Ft.

Not an identification guide, but a textbook of lichenology in Hungarian by the leading lichenologist in the country. Such works in national languages are essential to interest the students and naturalists in these fascinating fungi. It is wide-ranging, discussing the history of lichenology from earliest times to the molecular era; methods of study, chemical reactions, preservation of specimens; structure, reproduction and growth; physiology and ecophysiology; phytosociology (drawing especially on the studies of the late and most active Gallé László, 1908-1980); interactions with other organisms; an overview of classifications from the early 19th century to date, with current placements down to the genus level; bioindication of air pollution and ecological continuity, lichenometry, and other uses. The work concludes with 21 pages of references, an index to scientific names (including phytosociological ones), and a subject index. The whole is well presented, and will surely contribute to the promotion of lichenology in Hungary if it can become sufficiently widely distributed.

The lichens of the Tartry Mountains. By Eva Lisiká. 2005. VEDA, Slovak Academy of Sciences, Bratislava. Pp. 439. ISBN 80-224-0826-3. Price not indicated.

This book is in the best traditional of central European regional syntheses of information on lichens and lichenicolous fungi. It consists of an alphabetical list of 1119 lichen-forming and 60 lichenicolous fungi, of which 882 species of lichens and 37 lichenicolous fungi occur on the Polish side of the Tartra Mountains that form part of the Carpathian range. For each species, information on the habitat and distribution, and occurrences in particular regions are detailed with full collection information and references to literature and/or herbaria. A staggering 1753 synonyms are listed and cross-referenced, and the literature cited has over 400 entries. While the overall impression is of an extremely rich lichen biota, 31 species are listed as extinct, and a further 19 are now protected by law in the region. I was especially interested to note that one species of *Bryoria*, *B. smithii* was now extinct and that no less than seven other species in the same genus were now protected. Members of this genus have also declined dramatically in the UK. This painstaking compilation provides a baseline from which to measure future changes in the lichens of the region, as well as a key work for those exploring or endeavouring to identify lichens in the Carpathian mountains. The author is to be congratulated on bringing this compilation together.

Miscellaneous

Order out of chaos: Linnaean plant names and their types. By Charlie Jarvis. 2007. Linnean Society of London, Burlington House, Piccadilly, London WIV 0BF, UK. Pp. xii + 1016. illust. ISBN 978-0-9506207-7-0. Price £ 80.

This stupendous work is the culmination of the Linnaean Plant Name Typification Project, which was started in 1981. It covers all taxa treated as plants by Linnaeus, including fungi of all kinds. There is detailed discussion of how the typification of Linnaeus' names should be attempted, a summary of Linnaeus' life, and detailed discussions of works used by Linnaeus. The major part of the book, however, comprises entries for all species accepted by Linnaeus, listed alphabetically regardless of taxonomic group, with information as to original source, typifications made, notes on original material, and current names where known. This is an important reference work for mycologists dealing with names adopted by Linnaeus, and now needs to be the starting point when considering their typifications. The book is large-format and beautifully presented, and further is illustrated by examples from the Linnean collections, along with often-coloured illustrations from some of the important earlier historical works. It should be available in all major systematic libraries.

Fungi in the ancient world: How mushrooms, mildews, molds, and yeast shaped the early civilizations of Europe, the Mediterranean, and the Near East. By Frank Matthews Dugan. 2008. American Phytopathological Society Press, 3340 Pilot Knob Road, St Paul, MN 55121, USA. Pp. xi + 140, 13 figs. ISBN 978 0 89054 361 0. Price US $69.

This book, while not a systematic one, is included here as it contains much material that will be of value to teachers of mycology wishing to emphasize the multifarious ways in which fungi have been a part of, and influenced the development of, human civilizations. The topics considered are: baking and brewing, edible fungi, entheogens, poisonous fungi and mycotoxins, medicinal uses, plant and animal (including human) pathogens, rots, ecological roles, fungi in glacial ice or permafrost, ancient illustrations, folklore, ideas of fungal biology, and some miscellaneous attributions. There is, as in any work reaching back in time, a mixture of hard data with speculation based on meager clues. This adds to the book's interest, especially when considering topics sure to be contentious or even cause offence with some (not me), such as mentioning "Jesus ('the drug Man')" as "a minority view, albeit an entertaining one." Just what balance of coverage to accord to particular aspects, and what to include or not, must have been difficult choices to make, and no two mycologists would be likely to agree. I can understand reluctance not to broaden the geographical scope of the book to the Far East where so much information is to be found in works never translated into English, but, coming from the desk of a mycologist in North America, it would have been great if North and South American native people's involvement with mushrooms could also have been considered. Perhaps there will be more from these geographical areas, and more recent examples, in the author's forthcoming Fungi, folkways and fairy tales, stated to be

"in press"? Nevertheless, a great deal of research and reading has gone into the preparation of this most readable, well referenced, and, if anything, too slim, volume. I do hope the rather high price for such a modestly sized soft back will not deter too many potential mycological purchasers after an educating and enjoyable read for a long flight.

The Air Spora: A manual for catching and identifying airborne biological particles. By Maureen E. Lacey & Jonathan S. West. 2006. Springer, PO Box 17, 3300AA Dordrecht, The Netherlands. Pp. xv + 156, illustrated (incl. 12 coloured plates). ISBN 10: 0 387 30252 2, 13: 978 0 387 30252 2. Price £69 (recommended).

This is designed as a manual for those endeavouring to identify biological propagules in the air. The Rothamsted Experimental Station (Harpenden, UK) has a long and distinguished record in this field, especially since the pioneering work of Philip H. Gregory, later Jim M. Hirst, and subsequently John Lacey (who was married to Maureen). Six of the chapters are concerned with background material, spore trapping and sampling methods, basic microscopy, and counting, and one with identification. The identification chapter has just three pages of text and eight full-page plates of pollen and spore paintings, all at x1000. Four of the plates are devoted to fungi, and these together have paintings of 212 single spores, mainly from the UK but with some from Costa Rica, India, the USA or elsewhere. Many are named to species, but others to only to genus or merely, for example "ascospore, Costa Rica." It is not clear on what basis the selection was made. The paintings have been prepared largely by Maureen from fresh specimens or cultures, and not only trapped spores. Their quality is rather variable, and good interference contrast photographs would have been preferable; the paintings do not even show the longitudinal germ-slits of the representatives of three of the *Xylariaceae* included clearly.

There are some cautionary words on p.91 that the plates "will often give a hint of identification," but the text does not give an impression of the numbers of pollen and spore types that exist, and consequent problems of identification. The need in some cases to culture fungi from trapped spores in order to make an identification is not explained. Single spores cannot indicate the range of variation in a species, especially conidial fungi, and as there are no indications of numbers of species with similar spores, despite the admonitions, users will be tempted to make species identifications which are in reality suspect. For example, there is a danger that any *Pestalotiopsis*-type conidium found is likely to be referred to as *P. theae*. There are two spores labeled as *Curvularia lunata* that certainly differ, one from India and one from Singapore; one is almost twice as large as the other and has a massive central cell – both cannot be *C. lunata*. There is thus a danger of numerous misidentifications being made which could have quarantine, plant or human health, or economic repercussions. Can

Penicillium marneffei (human pathogen) or *Phoma lingam* (plant pathogen) be confidently identified from the conidia? Further, very few references to potentially helpful texts are provided.

There is a brief glossary, 12 pages of references, and, at 16 pages, a disproportionately detailed index. Perhaps not surprisingly, there is a strong UK focus as regards institutions mentioned, and all the suppliers listed in an Appendix are from the UK. The book is spirally bound, presumably in anticipation of intensive use by the microscope, but that would be regrettable with respect to identifications. This book is really one for the newcomer to sampling and trapping methods in aerobiology, and not one for the aerobiologist to use when making identifications. It is also available as an e-book (ISBN 10: 0 387 30253 0, 13: 978 0 387 30253 9).

Plant taxonomy: the systematic evaluation of comparative data. By Tod F. Stuessy. 2009. 2nd edn. Columbia University Press, New York, U.S.A. Pp. xxiii + 539, illustrated. ISBN 978-0-231-14712-5. Price £ 71.50.

In the absence of a mycological text on the principles of taxonomy, in my days as a fledgling taxonomist I was an avid user of Davis & Heywood (1963), which was then hot off the press – to the extent that my paperback copy disintegrated and had to be replaced by a hardbound one. After that work went out of print, the niche it had occupied was partly taken over by Tod Stuessey's book, the first edition of which was published in 1990, and in recent years I have been commending that book to graduate students instead. I state "partly" as Tod, who is currently Secretary-General of the International Association for Plant Taxonomy (IAPT) and based in Vienna, does not enter the minefields of nomenclature and typification. Neither does he consider fungi, for which I am glad under such a title, as that could have continued to perpetuate the myth that mycology is a part of botany. What the book does contain which makes it of value to mycologists, are: discussions of classification systems, approaches to classification (the natural, phyletic, phenetic, and cladistic); generic, species, and infraspecific rank concepts; types of taxonomic data, including the molecular and genetic; and the handling of taxonomic data. It is also a way into the broader systematic literature, with the "Literature Cited" section occupying a massive 129 pages in small type. If you are a mycologist wishing to get to grips with basic taxonomic concepts and methodologies, this is now the ideal starting point.

Davis PH, Heywood VH (1963) PRINCIPLES OF ANGIOSPERM TAXONOMY. Oliver & Boyd, Edinburgh.

NOMENCLATURAL NOVELTIES PROPOSED IN MYCOTAXON 107

Arthonia epitoninia Halici & Candan, p. 210
Arthonia rinodinicola Candan & Halici, p. 211
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Aurosphaeria flaviradians Sun J. Lee, Strobel, Eisenman, B. Geary, P.N. Vargas & S.A. Strobel, p. 466
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Chaetothyriomyces brasiliensis Pereira-Carvalho, Inácio & Dianese, p. 484
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Diatrype illicina Lar.N. Vassiljeva & S.L. Stephenson, p. 311
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Exobasidium rhododendri-russati Zhen Ying Li & L. Guo, p. 217
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Lachnum linderae J.G. Han, Raitv. & H.D. Shin, p. 459
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Lepiota babruka T.K.A. Kumar & Manim., p. 110

AUTHOR INDEX—VOLUME ONE HUNDRED SEVEN

Errata

Volume 105

p.23, abstract, line 2	for: *Aecidium ikramii*	read: *Aecidium haqii*

Volume 106

p.228, line 5	*for:* 1 555 m	*read:* 1,555 m
p.231, line 9 from bottom	for: *Agaricales* of Idonesia	read: *Agaricales* of Indonesia
p.410, Table 1, *Leuconectria grandis* entry:		
	for: **U984072**	*read:* **EU984072**
p.498, line 4 from bottom	*for*: France 3: 119 (1887)	*read*: France 3: 124 (1887)
p.501, line 23	*for:* extras-europeens.	*read:* extra-européens.

REVIEWERS—VOLUME ONE HUNDRED SEVEN

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

Brian P. Akers
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Jan Vesterholt
Zheng Wang
Roy Watling
Zhu L. Yang
Zhongyi Zhang
Wen-Ying Zhuang
Mikhail Zhurbenko

From the *Editor-in-Chief*

To our Readers

Table of contents has reluctantly disappeared from our covers and moved to the front pages. Covers are now prepared entirely in the Editor-in-Chief's office so that we have slightly better control over the colors....

Continuing changes include: heavier paper stock and slightly glossier paper but still of high archival quality

More color photos than ever before (enumerate numbers)

With this volume, our online weblists now cover every continent, including Africa and Antarctica. Authors continue to update their annotated species and distributions annually.

More submissions, as of this writing, we have already received 50 submissions for 2009; during 2008 we processed 238. the current volume contains 57 manuscripts by 168 authors and co-authors representing 32 countries, with 86 nomenclatural novelties proposed. (During 2008, Mycotaxon published a total of 252 new taxonomic names and presented 205 papers by 597 authors in four volumes covering 1844 pages.) Unfortunately, with the increase in submissions, manuscript turn around times are slightly longer than we wish....

Indexing picks up; beginning with Mycotaxon 110 we will have additional new Index Editors so that we can finally catch up. (rephrase).

Quality of submitted manuscripts continues to improve and we continue to encourage expert assistance throughout the review process, with problem manuscripts sent out for further review. Nomenclature is more rigorous than ever blah blah

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Moreno, Khalid & Alvarado
FIG 3. *Phallus calongei* sp. nov.
(p. 460)

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MYCOTAXON

Volume 108, pp. 1–4 April–June 2009

Proposals 016–020 to amend the International Code of Botanical Nomenclature

[Published concurrently in Taxon]

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Proposals (016–020) to amend the Code to make clear that it covers the nomenclature of fungi and to modify its governance with respect to names of organisms treated as fungi

A previous series of proposals to change the name of the International Code of Botanical Nomenclature [hereafter referred to as simply the Code] and make cognate adjustments (Hawksworth 1993, Taxon 42: 156–162) was ruled as rejected at the Tokyo Congress in 1993, the main proposal having received only 24 votes for and 158 against in the mail ballot. The issue has not been considered

* Author for correspondence

since, either at the St Louis Congress in 1999 or at the Vienna Congress in 2005. The evidence that *Fungi* are part of the same "superkingdom" as *Animalia*, which has been termed *Opisthokonta* (Adl & al. 2005, J. Eukaryot. Microbiol. 52: 399–451), is now overwhelming (e.g. James & al. 2006, Nature 443: 818–822.). In addition, since the series of International Mycological Congresses was initiated in 1971, the number of mycologists attending Nomenclature Section meetings at International Botanical Congresses has been minimal, rarely reaching double figures; very few mycologists are personal members of IAPT and thus able to vote in the mail ballot. In contrast, nomenclatural debates at recent International Mycological Congresses have attracted 200–300 participants.

Mycologists as a community wish to be seen as independent from botanists, as reflected in an informal vote at the International Mycological Congress in Cairns in 2006: although most participants did not complete voting slips, of those completed 36 votes were for either a separate mycological code or changing the name of the botanical code, and only 4 voted for no change (Rossman 2006, Mycol. Res. 110: 1254). In Cairns there were also forceful presentations from several leading mycologists on the need for the international mycological community, rather than the botanical community, to govern mycological nomenclature. In April 2007, a majority of the 39 mycologists participating in an international workshop on "*Aspergillus* systematics in the genomic era" in Utrecht "saw the need for a separate fungal nomenclatural code such as the code which the bacteriologists use" (Samson & al. 2007, Stud. Mycol. 59: 71–73). During August–September 2007, mycologists attending nomenclatural sessions or symposia at the Mycological Society of America annual meeting (Baton Rouge, Louisiana), the XV Congress of European Mycologists (St Petersburg, Russia), and the XVI Simposio Botánica Criptogámica de España (Léon, Spain) were asked to complete ballots on various issues related to the naming of fungi. A total of 95 questionnaires were completed from this geographically dispersed spectrum of mycologists. All did not vote on all issues, but of those voting, 73.3% (63) votes favoured a unified code covering all groups of organisms, but in the absence of a unified code 82.7% (62) wished to see decisions on fungal nomenclature voted at International Mycological Congresses rather than at International Botanical Congresses (Hawksworth 2007, Mycol. Res. 111: 1363–1364).

We trust that the proposals below will enable the international mycological community to assume full responsibility for the nomenclature of fungi. If accepted, the proposals made here could prevent an unfortunate and untimely schism. The proposals are divided into two groups, the first relating to the name of the Code and to clarification of its coverage, and the second to the decision-making on mycological matters under the Code.

In any event, a Nomenclatural Session will be convened during the IX International Mycological Congress in Edinburgh in 2010 that will debate the issue of a separate mycological code as well as consider and vote on proposals to change provisions in the current Code for fungal organisms. The Editor-in-Chief and Managing Editor of Mycotaxon have also agreed in principle to publish formal nomenclatural proposals relating to fungi that will also appear in Taxon. [Although it has become normal practice for such proposals to be published in Taxon, there is no requirement stated explicitly in the Code.] Decisions made at the Nomenclature Session in Edinburgh in 2010 are to be transmitted to the Nomenclature Section meetings in Melbourne in 2011. If the proposals made here are accepted in Melbourne, any decisions relating only to fungal organisms made in Edinburgh would be available for adoption there.

Proposals on the name and coverage of the Code

(016) Establish more clearly that the Code covers mycology, the study of fungi, as well as botany, commonly defined as "the study of plants" by:

(i) inserting "and Mycological" after "Botanical" in the title of the Code.

(ii) replacing "requires" by "and mycology require" at the start of Pre. 1.

(iii) replacing the "word 'plant'" by the "words "'plant' and 'fungus'", and inserting "and mycologists respectively" after "botanists" in the footnote to Pre. 1.

(iv) inserting in Div. III.1 footnote 1, "and mycological" after "botanical".

(017) Instruct the Editorial Committee to replace "plant(s)" by "plant(s) or fungus/fungi)" throughout the Code where this is intended to include all organisms covered by the Code.

Proposals on decision making for fungi in the Code

(018) Amend Div. III.2 to provide for the election of the Permanent Nomenclature Committee for Fungi by an International Mycological Congress:

In Div. III.2, insert in line 2 after "Taxonomy": "or in the case of the Committee for Fungi the International Mycological Association".

In Div. III.2, insert after "Congress": "except in the case of the Committee for Fungi which is elected at each International Mycological Congress".

(019) Amend Div. III.4 to permit decision-making on proposals relating solely to organisms treated as fungi to be taken at an International Mycological Congress:

In the first sentence, replace “two” by “three”, replace “and” before “ *(b)*” by “;”, and insert after “Congress” “, or *(c)* for proposals relating solely to organisms treated as fungi, a vote taken at the Nomenclatural Session of an International Mycological Congress”

Insert in the second paragraph after “voting”: “on proposals not relating solely to organisms treated as fungi”.

After Div. III.4 (b), insert a new final paragraph relating to “Qualifications for voting”: “*(c)* Voting at the Nomenclature Session of an International Mycological Congress (on proposals relating solely to organisms treated as fungi):

All officially registered full members of the Congress present at the Nomenclature Session have a personal vote. No accumulation or transfer of personal votes is permissible, and no institutional votes are granted.

(**020**) Insert a new Div. III.5 and footnote:

“The decisions taken at a Fungal Nomenclature Session relating solely to organisms treated as fungi are binding on the Nomenclature Section convened at the subsequent International Botanical Congress**. Such decisions will, however, be open for any editorial adjustments deemed necessary by the Editorial Committee. That Committee must include either the Secretary of the Committee for Fungi, or an alternate nominated by that Committee, as one of its members)”.

** “The Rapporteur-général appointed for that Congress, or an alternate appointed by the Rapporteur-général , is expected to attend the Nomenclature Session as a non-voting Advisor to the Session.”

Note — We wish to emphasise that, while most of us making these proposals have, or have recently, held positions in international mycological organizations or committees, we make them here in our personal capacities in anticipation of their consideration by mycologists as a whole at the 9th International Mycological Congress in 2010. Officers in two other key international mycological organizations decided not be co-proposers as they personally felt that an independent code governing the nomenclature of fungi is to be preferred.

Acknowledgement

We wish to record our thanks to John McNeill for his wise counsel and advice in formulating these proposals.

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A new species of *Berkleasmium* from Chongqing, China

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Abstract — *Berkleasmium daphniphylli* sp. nov. is described and illustrated. The specimen was collected from the subtropical regions of Chongqing, China. The type specimen is deposited in the Herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP).

Key words — anamorphic fungi, systematics, dead branches

Introduction

The genus *Berkleasmium* was established by Zobel (Corda 1854) with *B. cordeanum* Zobel (= *P. concinnum* (Berk.) S. Hughes) as the type species. Moore (1958, 1959) precisely defined the distinctive features of *Berkleasmium*. *Berkleasmium* produces phaeodictyospores, singly on short, unbranched conidiophores or sessile, in sporodochial conidiomata. Conidia are clavate, ellipsoidal or oblong, rounded at the ends or irregular, and often with a protruding hilum. About 29 species are described in this genus. Zhao & Zhang (2004) described 3 species of *Berkleasmium* occurring on dead branches or rotten wood in subtropical regions of China.

Taxonomic descriptions

Berkleasmium daphniphylli K. Zhang & X.G. Zhang, **sp. nov.** Figure 1

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Sporodochia disseminata, punctiformia, pulvinata, atra, nitentia. Mycelium semper immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 1–2 µm crassis compositum. Conidiophora micronematosa, mononematosa, simplicia vel ramificata, pallides, laevia, usque ad 20 µm longa, 2–3.5 µm crassa, vesiculis 3.5–6.5µm crassis praedita. Cellulae conidiogenae monoblasticae, integratae, terminales, clavatae vel

* Corresponding author

Fig. 1 Conidia and conidiophores of *B. daphniphylli.*

pyriformes, laeves. Conidia solitaria, acrogena, brunnea vel atro-brunnea, ellipsoidea, clavata, obovata vel pyriformia, laevia, cum transversis, longitudinalis, et obliquis septis.

Holotype: On dead branches of *Daphniphyllum oldhamii* (Hemsl.) Rosenth., subtropical forest of Jinyunshan, Chongqing, China, Aug. 2005, J. Ma, HSAUPV$_{0MJ}$0415.

Etymology: in reference to the host, *Daphniphyllum oldhamii.*

Sporodochia on dead wood scattered, punctiform, pulvinate, black, shining. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 1–2 µm thick. Conidiophores micronematous, mononematous, simple or branched, hyaline to pale brown, smooth, up to 20 µm long, 2–3.5 µm wide, with one bladderlike swelling 3.5–6.5 µm wide, Conidiogenous cells monoblastic, integrated, terminal, clavate or pyriform inflated, smooth. Conidia solitary, acrogenous, brown to dark brown, ellipsoidal, clavate, obovate or pyriform, smooth, with transverse, longitudinal and oblique septa, 16.5–28 µm long, 10–13 µm thick in the broadest part.

In conidial morphology, this species resembles *B. inflatum* (Holubová-Jechová 1987), *B. taishanense* (Zhao & Zhang 2004) and *Bahugada sundara* (Reddy & Rao 1984). However, the conidia of *B. daphniphylli* are smaller than those of either *B. inflatum* (40–48 × 19.5–21 µm) or *B. taishanense* (22–35 × 15–18.75 µm). In addition, conidia of *B. daphniphylli* have regular septa and fewer longitudinal and oblique septa, as opposed to those of *B. taishanense* which have irregular septa and more longitudinal and oblique septa. At the

same time, the inflated cells of conidiophores in *B. daphniphylli* also help in separating *B. daphniphylli* from *B. inflatum*. The conidia of *B. daphniphylli* are similar to those of *B. sundara*. However, the conidiogenous cells of this taxon are monoblastic, while *B. sundara* are polyblastic.

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MYCOTAXON

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A brief overview of and key to species of *Collema* from China

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Abstract — Forty-seven taxa of the lichen genus *Collema* belonging to 33 species are reported in the present paper. Among them, the following nine taxa are new to China: *Collema coccophorum*, *C. furfuraceum* var. *luzonense*, *C. kauaiense*, *C. nepalense*, *C. nipponicum*, *C. poeltii*, *C. polycarpon*, *C. subnigrescens* f. *caesium*, and *C. tenax* var. *expansum*. A key to the known species from China is given. *Collema pulchellum* var. *leucopeplum* and *C. latzelii* are excluded from the lichen flora of China.

Key words — *Collemataceae*, *Lecanorales*, lichenized *Ascomycetes*

Introduction

Collema is a crustose to foliose lichen genus belonging to *Collemataceae*, *Lecanorales*, *Ascomycota* (Kirk et al. 2001). It comprises about 80 species in the world (Kirk et al. 2001) and has been monographed by Degelius (1954, 1974).

The genus has been reported from China in 29 scattered publications with 59 taxa belonging to 43 species (Wei 1991; Jiang 1992, 1993; Liu & Wei 2003ab). The first species from China, *Collema limosum* was reported by Nylander & Crombie (1883). The second one, *C. coccophylloides* Nyl. (= *C. callibotrys* var. *coccophyllizum*), was recorded by Hue (1898). The two species, *Synechoblastus sublaevis* Jatta (= *C. furfureolum*) and *S. flaccidus* (Ach.) Körb. (≡ *C. flaccidum*) were reported by Jatta (1902). Zahlbruckner (1930, 1933) added six taxa, viz. *C. nigrescens*, *C. substipitatum*, *C. raishanum* Zahlbr. (= *C. leptaleum*), *C. ogatae* Zahlbr. (≡ *C. tenax* var. *ogatae*), *C. complanatum* and *C. japonicum*. Magnusson (1940) described two species from China, *C. kansuense* H. Magn. (= *C. tenax* var. *corallinum*) and *C. substellatum* H. Magn. (≡ *C. tenax* var. *substellatum*). Degelius (1974) added five taxa, viz. *C. glebulentum*, *C. pulchellum* var.

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subnigrescens, *C. subflaccidum*, *C. tenax* var. *vulgare* and *C. texanum*. The following 12 taxa were added to the Chinese *Collema* flora in eight papers (Wei 1991), viz. *C. pustuligerum* Hue (= *C. pulchellum* var. *pulchellum*) (Asahina 1952), *C. crispum* (Wu & Xiang 1981), *C. fasciculare* (Chen et al. 1981a), *C. peregrinum* (Ikoma 1983), *C. furfuraceum*, *C. ryssoleum*, *C. subnigrescens*, *C. tunaeforme* (Ach.) Ach. (= *C. fuscovirens*) [the above mentioned four species were recorded by Wu (1987)], *C. leptaleum* var. *biliosum*, *C. rugosum* [both in Thrower (1988)], *C. cristatum* (Wu & Qian 1989) and *C. subconveniens* (Chen et al. 1989).

Twelve taxa from China were described by Jiang (1992), viz. *C. beijingense*, *C. brevisporum*, *C. clavisporiferum*, *C. corniculatum*, *C. fanjingshanense*, *C. fusiosporum*, *C. lushanense*, *C. multipartitum* var. *granulosum*, *C. pulchellum* var. *multipartitum*, *C. sorediatum*, *C. tetrasporum* and *C. tianmuense*. The same author (Jiang 1993) reported 13 new records: *C. auriforme*, *C. callopismum*, *C. ceraniscum*, *C. cristatum* var. *marginale*, *C. latzelii*, *C. pulchellum* var. *leucopeplum*, *C. shiroumanum*, *C. tenax* var. *ceranoides*, *C. tenax* var. *crustaceum*, *C. tenax* var. *diffracto-areolatum*, *C. tenax* f. *papulosum*, *C. undulatum* var. *undulatum* and *C. undulatum* var. *granulosum*. Abbas & Wu (1998) reported *C. thamnodes* from Xinjiang. The occurrence of *Collema* in China was also reported by Magnusson (1944), Wang & Lai (1973), Chen et al. (1981b), Wu et al. (1984), Wei (1991), Abbas et al. (1996, 2001), Aptroot & Seaward (1999) and Guo (2005).

Although a large number of species were reported, there has not been any revisionary study on *Collema* from China. As part of this research, we synonymized five taxa described by Jiang (1992), recorded *C. multipartitum* as new to China (Liu & Wei 2003a), and described *C. sichuanense* and *C. substipitatum* var. *gonggashanense* (Liu & Wei 2003b). In this paper, we report 47 taxa belonging to 33 species, including nine new records, and we exclude two taxa from the Chinese lichen flora.

Materials and methods

Most of the specimens examined are deposited in the Herbarium Mycologicum Academiae Sinicae-Lichenes (HMAS-L); some are in the Herbarium of Xinjiang University (XJU) and the Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences (KUN).

For the morphological and anatomical studies, a dissecting (Motic) and a compound microscope (Olympus BHA) were routinely used for all materials. Hand sections were routinely made and examined with water as the mounting medium. Terms of morphology and anatomy follow Degelius (1954, 1974). Comments on the distribution of *Collema* taxa are mainly based on Wei (1991).

Results and discussion

Forty-seven taxa belonging to 33 species are accepted in the present paper. Among them, nine taxa are new to China: *C. coccophorum*, *C. furfuraceum* var. *luzonense*, *C. kauaiense*, *C. nepalense*, *C. nipponicum*, *C. poeltii*, *C. polycarpon*, *C. subnigrescens* f. *caesium* and *C. tenax* var. *expansum*; these are marked with "***" in the taxonomic list. Both *C. pulchellum* var. *leucopeplum* and *C. latzelii* are misapplied names and are therefore excluded from the lichen flora of China.

Collema F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

Thallus crustose to foliose, gelatinized; upper side smooth, rugose to ridged or pustulate. Apothecia superficial, commonly sessile with constricted base. Thallus without cortex, homoeomerous; photobiont *Nostoc*. Apothecia zeorine; thalline exciple with or without a pseudocortex; proper exciple euthyplectenchymatous, subparaplectenchymatous or euparaplectenchymatous; ascospores 8 per ascus, 1- to multi-septate or somewhat muriform, variable in size and shape, colorless.

Corticolous, saxicolous to terricolous.

Key to the taxa of *Collema* from China

1. Thallus crustose to subfoliose, often fenestrate; lobes indistinct or absent 2
1. Thallus foliose to somewhat subfoliose, not fenestrate (but see *C. nepalense*); lobes distinct 9
2. Thallus with isidia, rugose on upper side; apothecia absent .... *C. leptaleum* var. *biliosum*
2. Thallus without isidia 3
3. Spores submuriform (with longitudinal septa) 4
3. Spores without longitudinal septa 5
4. Spores cubic .... *C. lushanense*
4. Spores ellipsoid .... *C. nipponicum*
5. Spores > 10-celled, vermiform and curved in various ways, > 65 µm long .... *C. fasciculare*
5. Spores < 10-celled, not vermiform, straight or curved 6
6. Spores bacillar and 4-celled, < 50 µm long; proper exciple euparaplectenchymatous .... *C. leptaleum* var. *leptaleum*
6. Spores not bacillar, > 4-celled 7
7. Spores dumbbell-shaped, < 50 µm long; proper exciple euthyplectenchymatous .... *C. shiroumanum*
7. Spores fusiform to acicular, > 60 µm long 8

8. Proper exciple euthyplectenchymatous to subparaplectenchymatous
 . . . . *C. substipitatum* var. *substipitatum*
8. Proper exciple euparaplectenchymatous . . . . . . *C. substipitatum* var. *gonggashanense*

9. Thallus rugose on both sides . . . . *C. auriforme*
9. Thallus rugose only on upper side or not rugose 10

10. Lobes swollen and sometimes plicate (at least in the tips) 11
10. Lobes not swollen and not plicate 21

11. Lobes convex, repeatedly furcate . . . . *C. texanum*
11. Lobes plane to concave 12

12. Thallus commonly < 2 cm diam.; lobes < 2 mm wide 13
12. Thallus > 2 cm diam.; lobes > 2 mm wide 16

13. Lobes erect, often forming erect clusters . . . . *C. tenax* var. *corallinum*
13. Lobes adnate to ascending, not forming erect clusters 14

14. Thallus areolate, isidiate . . . . *C. tenax* var. *diffracto-areolatum*
14. Thallus not areolate, nonisidiate 15

15. Spores 2-celled . . . . *C. coccophorum*
15. Spores 4-celled to submuriform . . . . *C. tenax* var. *crustaceum*

16. Thallus > 5 cm diam.; lobes > 5 mm wide; upper side glossy
 . . . . *C. tenax* var. *expansum*
16. Thallus < 5 cm diam.; lobes < 5 mm wide; upper side dull 17

17. Lobes long, up to 15 mm long . . . . *C. tenax* var. *substellatum*
17. Lobes short, commonly < 5 mm long 18

18. Upper side with erect accessory lobules . . . . *C. tenax* var. *ogatae*
18. Upper side not so 19

19. Thallus isidiate . . . . *C. tenax* f. *papulosum*
19. Thallus nonisidiate 20

20. Spores 4-celled to submuriform; proper exciple euthyplectenchymatous
 . . . . *C. tenax* var. *vulgare*
20. Spores 4-celled; proper exciple subparaplectenchymatous to
 euparaplectenchymatous . . . . *C. polycarpon*

21. Lobes > 5 mm wide and plane 22
21. Lobes < 5 mm wide, concave, plane or convex 38

22. Upper side of the thallus with regular ridges or pustules 23
22. Upper side of the thallus without regular ridges or pustule 33

23. Upper side of the thallus with isidia 24
23. Upper side of the thallus without isidia 25

24. Proper exciple euparaplectenchymatous . . . . *C. furfuraceum* var. *luzonense*
24. Proper exciple euthyplectenchymatous . . . . *C. furfuraceum* var. *furfuraceum*

25. Thalline exciple with pseudocortex; proper exciple euthyplectenchymatous 26
25. Thalline exciple without pseudocortex; proper exciple
 euparaplectenchymatous 31

26. Spores fusiform to ellipsoid 27
26. Spores broadly acicular to acicular 29
27. Thallus often fenestrate; apothecia pruinose; spores 4–6-celled .... *C. nepalense*
27. Thallus not fenestrate; apothecia epruinose; spores 6-celled 28
28. Spores > 5 µm wide; saxicolous .... *C. ryssoleum*
28. Spores < 5 µm wide; corticolous .... *C. sichuanense*
29. Spores acicular, 6–10-celled, < 5 µm wide .... *C. nigrescens*
29. Spores broadly acicular, 6-celled, > 6 µm wide 30
30. Apothecia pruinose .... *C. subnigrescens* f. *caesium*
30. Apothecia epruinose .... *C. subnigrescens* f. *subnigrescens*
31. Spores > 65 µm long; upper side of the thallus mainly ridged .... *C. complanatum*
31. Spores < 65 µm long 32
32. Upper side of the thallus mainly ridged .... *C. pulchellum* var. *subnigrescens*
32. Upper side of the thallus mainly pustulate .... *C. pulchellum* var. *pulchellum*
33. Spores with longitudinal septa .... *C. subconveniens*
33. Spores without longitudinal septa 34
34. Thallus rarely isidiate; proper exciple euparaplectenchymatous .... *C. japonicum*
34. Thallus isidiate; proper exciple euthyplectenchymatous to subparaplectenchymatous 35
35. Thallus with squamiform isidia .... *C. flaccidum*
35. Thallus with globular to teretiform isidia 36
36. Isidia teretiform, > 1 mm long, repeatedly branched .... *C. glebulentum*
36. Isidia globular to teretiform, < 1 mm long, not branched or slightly so 37
37. Upper side with irregular ridges or pustules; isidia teretiform .... *C. rugosum*
37. Upper side without ridges or pustules; isidia often globular .... *C. subflaccidum*
38. Thallus nonisidiate 39
38. Thallus isidiate 42
39. Lobes convex, < 1 mm wide, not crisped; proper exciple euparaplectenchymatous .... *C. multipartitum*
39. Lobes concave to plane 40
40. Lobes canaliculate at least in part 41
40. Lobes not so, strongly undulate .... *C. undulatum* var. *undulatum*
41. Lobes irregularly furcate, incised with lobules in margin .... *C. cristatum* var. *cristatum*
41. Lobes regularly furcate, often entire in margin .... *C. cristatum* var. *marginale*
42. Isidia squamiform when old; lobes crisped 43
42. Isidia globular to cylindrical when old; lobes not crisped or slightly so 44
43. Spores < 20 µm long .... *C. furfureolum*
43. Spores > 20 µm long .... *C. crispum*

44. Lobes concave, furcate . . . . *C. undulatum* var. *granulosum*
44. Lobes plane to somewhat concave, not branched or slightly so 45
45. Upper side of the thallus irregularly pustulate . . . . *C. fuscovirens*
45. Upper side of the thallus not pustulate 46
46. Proper exciple euthyplectenchymatous to subparaplectenchymatous. . . . . *C. poeltii*
46. Proper exciple euparaplectenchymatous . . . . *C. kauaiense*

1. *Collema auriforme* (With.) Coppins & J.R. Laundon, in Laundon, Lichenologist 16(3): 228 (1984).

This species is characterized by 1) thallus with distinct wrinkles on both sides; 2) lobes 4–10 mm wide, irregularly branched; 3) proper exciple euparaplectenchymatous; 4) spores submuriform, (17–) 27–40.5 (–51) × 6.5–15.5 (–17) µm. It is muscicolous on soil-covered rocks.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1250 m, Gao XQ, 758. HEBEI, Mt. Xiaowutaishan, 1800 m, Jiang ZG, 3627. QINGHAI, Huangcheng, 3000 m, 11.IX.1958, Ma QM, 9. XINJIANG, Yecheng, 3000 m, 8.VIII.1992, Abbas A, 92-0244.

Literature records for China: JILIN, HEBEI (Jiang 1993, p. 70), SHAANXI (Guo 2005, p. 46), QINGHAI (Jiang 1993, p. 70; Guo 2005, p. 46), XINJIANG (Guo 2005, p. 46).

2. *Collema coccophorum* Tuck., Proc. Am. Acad. Arts & Sci. 5: 385 (1862).***

This species is characterized by 1) thallus foliose, 3 cm diam.; 2) lobes numerous, concave, 1–2 mm wide, with swollen ends; 3) thallus and thalline exciple not pseudocorticate; 4) proper exciple euthyplectenchymatous; 5) spores fusiform to ovate, 2-celled, (17–) 20.5–25 × 6.5–9 µm. It is terricolous.

In gross morphology, *C. coccorphorum* resembles some infraspecific taxa of *C. tenax*, which differs in having 4-celled to submuriform spores.

Selected specimens examined: NEI MONGOL, Xilinhot, Inner Mongolian Grassland Ecosystem Research Station of Academia Sinica, 1150 m, 27.VII.2003, Liu HJ, 740. HUNAN, Mt. Hengshan, 1200 m, 1.IX.1964, Zhao JD & Xu LW, 10351.

3. *Collema complanatum* Hue, J. Bot. (Morot) 20: 85 (1906).

This species differs from other species of *Collema* in having long, 6–10-celled, acicular spores (commonly > 65 µm long). It is corticolous.

Selected specimens examined: NEI MONGOL, Ergun Zuoqi, 1200 m, 16.VIII.1985, Gao XQ, 1620. JILIN, Mt. Changbaishan, 1100 m, 7.VIII.1977, Wei JC, 2776. HEILONGJIANG, Dailing, 450 m, 2.X.1975, Wei JC, 2055. SHAANXI, Mt. Taibaishan, 2300 m, 9.VII.1988, Ma CH, 60 [The above mentioned specimens were cited by Jiang (1993) as *C. pulchellum* var. *leucopeplum*]. ANHUI, Yuexi, 1150 m, 4.IX.2001, Liu HJ, 444. JIANGXI, Mt. Lushan, Zhao JD et al., 579 [Jiang (1993) as *C. shiroumanum*]. YUNNAN, Lijiang, Mt. Yulongshan, 3050 m, 15.XII.1964, Wei JC, 2504-5 [Jiang (1993) as *C. pulchellum* var. *pulchellum*].

Literature records for China: SHAANXI (Guo 2005, p. 46), ZHEJIANG (Wu & Qian 1989, p. 194), FUJIAN (Wu et al. 1984, p. 1), TAIWAN (Zahlbruckner 1933, p. 26; Wang & Lai 1973, p. 90; Degelius 1974, p. 161), HONG KONG (Thrower 1988, p. 83; Jiang 1993, p. 72).

4. ***Collema crispum*** (Huds.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

This species is characterized by the foliose thallus with crisped, < 5 mm wide lobes. It is terricolous.

Specimen examined: XIZANG, Lhünzê, 3600 m, 5.VII.1975, Zang M, 1117.

Literature records for China: SHAANXI (Wu 1987, p. 53), JIANGSU (Wu & Xiang 1981, p. 2; Wu & Qian 1989, p. 194; Wu 1987, p. 53), ZHEJIANG (Wu & Qian 1989, p. 194).

5. ***Collema cristatum*** (L.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

5.1. var. ***cristatum***

This variety is characterized by 1) thallus foliose, often > 5 cm diam.; 2) lobes radiating and irregularly furcate, < 2 mm wide, somewhat concave; 3) thalline exciple without pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores ellipsoid, 4-celled to submuriform, 17–28 × 6.5–12 µm. It is saxicolous to terricolous, often growing together with var. *marginale*.

Selected specimens examined: NEI MONGOL, Hexigten Qi, 1500 m, 29.VII.1985, Gao XQ, 1049. HEBEI, Mt. Xiaowutaishan, 2100 m, Jiang ZG, 3692. XINJIANG, Zhaosu, 2.VII.1992, Abbas A, 219, 221. Wensu, Mt. Tomur, 2600 m, 30.VI.1977, Wang XY et al., 341.

Literature records for China: BEIJING, HEBEI (Jiang 1993, p. 70), XINJIANG (Guo 2005, p. 46).

5.2. var. ***marginale*** (Huds.) Degel., Symb. Bot. Upsal. 13(2): 316 (1954).

This variety is similar in anatomy (thalline and proper exciples, spore shape and size) to var. *cristatum*, but differs in having the regularly furcate lobes. It is saxicolous to terricolous.

Selected specimens examined: NEI MONGOL, Hexigten Qi, 1500 m, 29.VII.1985, Gao XQ, 1035. HEBEI, Mt. Baihuashan, 1500 m, 18.VII.1964, Xu LW & Zong YC, 8461. XINJIANG, Zhaosu, 6.VII.1993, Abbas A, 930172 [Abbas & Wu (1998) and Abbas et al. (1996, 2001) as *C. fuscovirens*].

Literature records for China: BEIJING, NEI MONGOL (Jiang 1993, p. 70), XINJIANG [Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 62; Abbas et al. 2001, p. 363 (All cited as *C. fuscovirens* in the abovementioned three literatures); Guo 2005, p. 46].

6. ***Collema fasciculare*** (L.) Weber ex F.H. Wigg., Primit. Fl. Holsat.: 89 (1780).

This species differs from all other crustose to subfoliose Chinese taxa of *Collema* in having 10–16-celled, vermiform spores that are > 65 µm long. It is corticolous.

Collema fasciculare can be well distinguished from *C. complanatum* by its crustose to subfoliose thallus without ridges or pustulates on the upper side.

Selected specimens examined: JILIN, Mt. Changbaishan, 1100 m, 8.VIII.1977, Wei JC, 2807-1. SICHUAN, Mt. Emeishan, 2200 m, 14.VIII.1963, Zhao JD & Xu LW, 7322.

Literature records for China: HEILONGJIANG (Chen et al. 1981a, p. 134; Wu 1987, p. 53), SHAANXI (Wu 1987, p. 53).

7. *Collema flaccidum* (Ach.) Ach., Lichenogr. Univ.: 647 (1810).

This species is characterized by its foliose thallus with broad (> 5 mm wide) lobes, irregular pustules or ridges on the upper side, and squamiform isidia. Spores fusiform, 23.8–37.4 × 5–8.5 μm. It is corticolous.

Selected specimens examined: HEILONGJIANG, Mulin, 610 m, 21.VII.1977, Wei JC, 2545-1. ANHUI, Yuexi, 1670 m, 5.IX.2001, Huang MR, 655. SICHUAN, Mt. Emeishan, 2200 m, Zhao JD et al., 7399. XINJIANG, Mt. Altay Shan, 1700 m, Abbas A, 2002948.

Literature records for China: SHAANXI (Jatta 1902, p. 480; Zahlbruckner 1930, p. 76; Wu 1987, p. 53), JIANGSU (Wu 1987, p. 53), ANHUI (Wu & Qian 1989, p. 194), XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 61; Abbas et al. 2001, p. 363; Guo 2005, p. 46).

8. *Collema furfuraceum* (Arnold) Du Rietz, Ark. Bot. 22A(13): 3 (1929).

8.1. var. ***furfuraceum***

This taxon is characterized by 1) thallus foliose, with regular ridges and pustules on upper side; 2) lobes > 5 mm wide; 3) cylindrical isidia on ridges and pustules; 4) thallus and thalline exciple often with typical pseudocortex; 5) proper exciple euthyplectenchymatous to somewhat subparaplectenchymatous; 6) spores fusiform, commonly 6-celled, 36–67 × 3.5–6.5 μm. It is corticolous.

In its isidia and lobe width, this taxon resembles *C. subflaccidum*, from which it can be separated by the regular ridges and pustules on the upper side.

Selected specimens examined: JILIIN, Mt. Changbaishan, 20.VIII.1977, Wei JC, 3118. SHAANXI, Mei Xian, 800 m, 12.IV.1963, Ma QM & Zong YC, 2008. ANHUI, Jinzhai, 680 m, 10.IX.2001, Huang MR, 674. HUNAN, Mt. Hengshan, 600–1000 m, 31.VIII.1964, Zhao JD & Xu LW, 9872, 10011. SICHUAN, Mt. Emeishan, 1400–3160 m, 20.VIII.1963, Zhao JD & Xu LW, 7704, 8220. XINJIANG, Mt. Tianshan, 2500 m, 7.VIII.1978, Wang XY, 1205.

Literature records for China: ZHEJIANG, ANHUI, JIANGXI (Wu 1987, p. 53), SHAANXI (Wu 1987, p. 53; Guo 2005, p. 46), XINJIANG (Guo 2005, p. 46).

8.2. var. ***luzonense*** (Räsänen) Degel., Symb. Bot. Upsal. 20(2): 179 (1974).***

This taxon differs from var. *furfuraceum* in having euparaplectenchymatous proper exciple. It is corticolous.

Specimen examined: HUNAN, Mt. Hengshan, 500 m, 11.II.1965, Wei JC, 3030.

9. *Collema furfureolum* Müll. Arg., Flora 72: 142 (1889).

This species is characterized by 1) thallus foliose, without ridges and pustules; 2) end lobes 2–3 mm wide, slightly crisped; 3) isidia superficial, squamiform; 4) thallus without typical pseudocortex. It is saxicolous.

Specimen examined: SHAANXI, Mt. Taibaishan, 4.VI.1963, Wei JC et al., 2718.

Literature records for China: SHAANXI (Jatta 1902, p. 481; Zahlbruckner 1930, p. 76; Degelius 1974, p. 79; Guo 2005, p. 46), ZHEJIANG (Degelius 1974, p. 79).

10. *Collema fuscovirens* (With.) J.R. Laundon, Lichenologist 16(3): 219 (1984).

This species is characterized by the branched foliose thallus with < 5 mm wide lobes and irregularly pustulate upper side, and obovate to ellipsoid spores (14–26 × 6.5–12 μm). It is saxicolous to terricolous.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1250 m, 3.VII.1985, Gao XQ, 729-1. SHAANXI, Mt. Taibaishan, 1200 m, 7.VII.1988, Gao XQ, 2937 [Jiang (1993) as *C. undulatum* var. *undulatum*]. SICHUAN, Huanglong, 3325 m, 25.IX.2001, Jiang YM & Zhao ZT, S220. XIZANG, Nyalam, 3350 m, 21.V.1966, Wei JC & Chen JB, 1083-1. XINJIANG, Mt. Altay Shan, Abbas A, 98-006-8a.

Literature records for China: SHAANXI (Wu 1987, p. 55), JIANGSU (Wu 1987, p. 55; Wu & Qian 1989, p. 195), XINJIANG (Guo 2005, p. 46).

11. *Collema glebulentum* (Nyl. ex Cromb.) Degel., in Magnusson, Ark. Bot. ser. 2, 2(2): 88 (1952).

The species is distinct from all other species of *Collema* by the repeatedly branched and large isidia (often > 1 mm long). It is corticolous.

Specimen examined: JILIN, Mt. Changbaishan, 16.VIII.1977, Wei JC, 3041.

Literature records for China: SHAANXI (Guo 2005, p. 46). XINJIANG (Degelius 1974, p. 144; Abbas & Wu 1998, p. 63; Guo 2005, p. 46).

12. *Collema japonicum* (Müll. Arg.) Hue, Nouv. Arch. Mus. Hist. Nat. Paris Sér. 3, 10: 220 (1898).

This species is characterized by 1) thallus foliose with > 5 mm wide lobes; 2) upper side smooth or with irregular pustules and ridges; 3) thalline exciple with pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores fusiform, 6-celled, 27–54 (–67) × 5–9 μm. It is corticolous, rarely saxicolous.

Selected specimens examined: SHAANXI, Mt. Taibaishan, 1100 m, 30.VI.1963, Wei JC et al., 2779. ANHUI, Jinzhai, 650 m, 10.IX.2001, Liu HJ, 548. HUNAN, Mt. Hengshan, 960 m, 2.IX.1964, Zhao JD & Xu LW, 10288. SICHUAN, Mt. Gonggashan, 2500 m, 1.VII.1982, Wang XY et al., 8646.

Literature records for China: SHAANXI (Guo 2005, p. 46), ANHUI, ZHEJIANG (Wu & Qian 1989, p. 195), TAIWAN (Zahlbruckner 1933, p. 26; Wang & Lai 1973, p. 90).

13. ***Collema kauaiense*** H. Magn., in Magnusson & Zahlbruckner, Ark. Bot. 31A(1): 63 (1943).***

This species is characterized by 1) thallus foliose, 2 cm diam.; 2) lobes 2–3 mm wide, margin crisped, not swollen; 3) isidia on upper side, laminal, globular to somewhat squamiform; 4) apothecia pruinose; 5) proper exciple euparaplectenchymatous; 6) spores fusiform, 4–6-celled, 23.5–34.5 × 6.5–10 μm. It is corticolous.

In having pruinose apothecia, this species resembles *C. nepalense* and *C. subnigrescens* f. *caesium*, from which it can be separated by the smaller thallus (< 3 cm diam.), narrower lobes (< 5 mm wide) and upper side without ridges and pustules.

Specimen examined: SICHUAN, Mt. Gonggashan, 2500 m, 1.VII.1982, Wang XY et al., 8638.

14. ***Collema leptaleum*** Tuck., Proc. Am. Acad. Arts & Sci. 6: 263 (1866).

14.1. var. ***leptaleum***

= *C. brevisporum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 83 (1992).

This variety is similar in appearance to var. *biliosum*, but differs in lacking isidia and in having numerous apothecia. It is corticolous. See Liu & Wei (2003a) for details.

Literature records for China: JILIN, HEILONGJIANG, ZHEJIANG, YUNNAN (Liu & Wei 2003a, p. 350), TAIWAN (Zahlbruckner 1933, p. 26, 1940, p. 247; Wang & Lai 1973, p. 90; Degelius 1974, pp. 102 & 107), HONG KONG (Thrower 1988, p. 84).

14.2. var. ***biliosum*** (Mont.) Degel., Symb. Bot. Upsal. 20(2): 105 (1974).

This taxon is characterized by 1) thallus crustose to subfoliose, sometimes fenestrate; 2) upper side irregularly rugose, with globular isidia; 3) apothecia absent. It is corticolous.

Selected specimens examined: JILIN, Mt. Changbaishan, Wenquan, 16.VIII.1977, Wei JC, 3048. NEI MONGOL, Horqin Youyi Qianqi, 1200 m, 6.VII.1985, Gao XQ, 892-1. SHAANXI, Mt. Taibaishan, 4.VI.1963, Wei JC et al., 2718-3. JIANGXI, Mt. Lushan, 21.IV.1960, Zhao JD, 519. YUNNAN, Weixi, 2900 m, 18.VII.1981, Wang XY et al., 3848. HONG KONG, 1.I.1973, Thrower SL, 1527.

Literature records for China: SHAANXI (Guo 2005, p. 46), HONG KONG (Thrower 1988, p. 85).

15. ***Collema lushanense*** Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16: 83 (1992).

Type(!): JIANGXI, Mt. Lushan, 3.IV.1960, Zhao JD et al., 577 (HMAS-L). Corticolous.

This species is characterized by 1) thallus subcrustaceous to subfoliose, markedly rugose, fenestrate; 2) isidia and pruina absent; 3) thallus and thalline exciple

without pseudocortex; 4) proper exciple euparaplectenchymatous; 5) spores 8 per ascus, cubic, submuriform, 13.5–17 × 8.5–10 μm. It is corticolous.

This species differs from other Chinese *Collema* taxa in having cubic spores. It is endemic to China and known only from the original locality.

Literature records for China: JIANGXI (Jiang 1992, p. 83).

16. *Collema multipartitum* Sm., in Smith & Sowerby, Engl. Botan. vol. 36, tab. 2582 (1814).

= *C. multipartitum* var. *granulosum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 83 (1992).

This species is characterized by the foliose thallus with narrow (< 5 mm wide), repeatedly furcate, convex lobes, euparaplectenchymatous proper exciple, and 4-celled linear-oblong spores (34–37.4 × 5–6.5 μm). It is saxicolous. See Liu & Wei (2003a) for details.

Literature records for China: HEBEI (Liu & Wei, 2003a, p. 352).

17. *Collema nepalense* Degel., Symb. Bot. Upsal. 20(2): 157 (1974).***

This species is characterized by 1) thallus foliose, often fenestrate; 2) upper side regularly pustulate to somewhat ridged; 3) lobes often > 5 mm wide; 4) thalline exciple with distinct pseudocortex; 5) proper exciple euthyplectenchymatous to somewhat subparaplectenchymatous; 6) spores fusiform, 6-celled, (34–) 38–44 (–51) × (3.5–) 5–7 μm. It is corticolous.

Selected specimens examined: YUNNAN, Lijiang, 3050 m, 15.XII.1964, Wei JC, 2493-1. XIZANG, Zogang, Mt. Meilixueshan, 3200 m, 8.X.1982, Su JJ, 5501.

18. *Collema nigrescens* (Huds.) DC., in Lamarck & de Candolle, Fl. Franç., ed. 3, 2: 384 (1805).

This species is mainly characterized by its foliose thallus with regular ridges and pustules, pseudocorticate thalline exciple, euthyplectenchymatous to subparaplectenchymatous proper exciple and 6–10-celled, transversely septate spores. It differs from *C. subnigrescens* by its longer [58–87 (–102) μm vs 54–69 (–85) μm] and narrower [3.5–5 μm vs (3.5–) 5–7 μm] spores with more septa [6–10-celled vs 6-celled]. It is corticolous.

Selected specimens examined: HEILONGJIANG, Dailing, 450 m, 1.VIII.2002, Chen JB & Hu GR, 22030. NEI MONGOL, Hexigten Qi, 1950 m, 30.VII.1985, Gao XQ, 1084.

Literature records for China: SHAANXI, ZHEJIANG, ANHUI, GUANGDONG (Wu 1987, p. 54), SICHUAN (Zahlbruckner 1930, p. 76), HUNAN, YUNNAN, FUJIAN (Wu 1987, p. 54; Zahlbruckner 1930, p. 76).

19. *Collema nipponicum* Degel., Symb. Bot. Upsal. 20(2): 53 (1974).***

This species is characterized by 1) thallus subfoliose, 2–3 cm diam.; 2) lobes swollen towards margin; 3) thallus and thalline exciple without pseudocortex;

4) proper exciple euparaplectenchymatous; 5) spores ellipsoid, submuriform, 27–35 × 9–13.5 μm. It grows on soil-covered rocks.

In gross morphology *C. nipponicum* resembles some infraspecific taxa of *C. tenax*, but differs in the euparaplectenchymatous proper exciple.

Specimens examined: XINJIANG, Tomort, 2800–2900 m, 3–25.III.1977, Wang XY et al., 394, 533-1.

20. *Collema poeltii* Degel., Symb. Bot. Upsal. 20(2): 96 (1974).***

This species is characterized by 1) thallus foliose, often fragmented, 2–4 cm diam.; 2) lobes 1–2 mm wide, slightly crisped; 3) thalline exciple with typical pseudocortex; 4) proper exciple euthyplectenchymatous to subparaplectenchymatous; 5) spores fusiform, (4–)6-celled, 28–45 × 7–10 μm. It is saxicolous or terricolous.

Selected specimens examined: HEBEI, Mt. Donglingshan, 18.VIII.1957, Zhao JD, 008 [Jiang (1993) as *C. latzelii*]. HENAN, Mt. Jigongshan, 20.IX.2001, Liu HJ, 705. ANHUI, Yuexi, 1450 m, 5.IX.2001, Liu HJ, 477. YUNNAN, Xichou, 1580 m, 17.XI.1991, Chen JB, 5173.

21. *Collema polycarpon* Hoffm., Deutschl. Fl. 2: 102 (1796).***

This species is characterized by 1) thallus foliose, 2–3 cm diam.; 2) lobes 1–2 mm wide, margins slightly swollen; 3) thallus and thalline exciple without pseudocortex; 4) proper exciple subparaplectenchymatous; 5) spores fusiform, 4-celled, 17–26 × 6–8.5 μm. It is terricolous.

Specimen examined: YUNNAN, Yingjiang, 1500 m, Wang X. Y. et al., 3277.

22. *Collema pulchellum* Ach., Syn. Meth. Lich.: 321 (1814).

22.1. var. ***pulchellum***

This taxon is characterized by the foliose thallus with regular pustules on the upper side, euparaplectenchymatous proper exciple and acicular spores (commonly < 5 μm wide). It is corticolous. See Liu & Wei (2003a) for details.

Selected specimens examined: HEILONGJIANG, Tahe, 500 m, 3.VIII.1984, Gao XQ, 084. JILIN, Mt. Changbaishan, 1000 m, 25.VII.1983, Wei JC & Chen JB, 6053, 6111, 6150 [The above three specimens were cited by Jiang (1993) as *C. pulchellum* var. *leucopeplum*].

Literature records for China: Northeast China (Asahina 1952, p. 375; Degelius 1974, p. 176), NEI MONGOL, HEILONGJIANG, JILIN, HEBEI, ANHUI, HUNNAN (Liu & Wei 2003a, p. 354), YUNNAN (Degelius 1974, p. 176; Jiang 1993, p. 72; Liu & Wei 2003a, p. 354), FUJIAN (Jiang 1993, p. 72; Liu & Wei 2003a, p. 354), SHAANXI, XINJIANG (Liu & Wei 2003a, p. 354; Guo 2005, p. 46).

22.2. var. ***subnigrescens*** (Müll. Arg.) Degel., Symb. Bot. Upsal. 20(2): 173 (1974).
= *C. corniculatum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 85 (1992).

This taxon differs from var. *pulchellum* in having regular ridges rather than pustules on the upper side and broader spores (commonly > 5 μm wide). It is corticolous.

Specimens examined: see Liu & Wei (2003a) for details.

Literature records for China: HEILONGJIANG (Liu & Wei 2003a, p. 355), SHAANXI, QINGHAI (Liu & Wei 2003a, p. 355; Guo 2005, p. 46), HUBEI (Chen et al. 1989, p. 420; Liu & Wei 2003a, p. 355), SICHUAN, GUIZHOU (Liu & Wei 2003a, p. 355), YUNNAN (Degelius 1974, p. 176; Liu & Wei 2003a, p. 355), XIZANG (Liu & Wei 2003a, p. 355), HONGKONG (Thrower 1988, p. 86; Liu & Wei 2003a, p. 355).

23. *Collema rugosum* Kremp., in Fenzl, Reise Österr. Novara Bot. 1: 128 (1870).

The species is characterized by its foliose thallus with > 5 mm wide lobes, distinct ridges on upper side and rugose to isidiate apothecial margin. It is corticolous.

It is similar to *C. subflaccidum,* but differs in having isidiate apothecial margins and distinct ridges on the upper side of the thallus.

Selected specimens examined: HEILONGJIANG, Jingpohu Lake, 30.VII.1977, Qian ZG, Herbarium no.: 021472 (HMAS-L). ANHUI, Yuexi, 950 m, 4.IX.2001, Liu HJ, 458. JIANGXI, Mt. Lushan, 2.IV.1960, Zhao JD, 519-1; GUIZHOU, Daozhen, 1600 m, 11.VI.1987, Wu, 2929. XINJIANG, Kalas, 2300 m, Abbas A, 980088.

Literature records for China: HONG KONG (Thrower 1988, p. 87; Aptroot & Seaward 1999, p. 83). XINJIANG (Guo 2005, p. 46).

24. *Collema ryssoleum* (Tuck.) A. Schneid., Guide Study Lich.: 181 (1898).

This species resembles *C. nigrescens* and *C. subnigrescens* in general appearance, but differs in having 4–6-celled, fusiform to ellipsoid spores (23.5–40.5 × 4.5–9.5 μm), and in being saxicolous rather than corticolous.

Selected specimens examined: HEBEI, Lingshou, Manshan, 1400 m, 13.VI.1986, Jiang ZG, 2000. SHAANXI, Mt. Taibaishan, 2750 m, 11.VII.1988, Ma CH, 123. SICHUAN, Mt. Emeishan, 2800 m, 18.VIII.1963, Zhao JD & Xu LW, 8140. YUNNAN, Mt. Gongshan, Dulongjiang, 2000 m, 3.IX.1982, Su JJ, 3978.

Literature records for China: SHAANXI (Wu 1987, p. 54; Guo 2005, p. 46).

25. *Collema shiroumanum* Räsänen, Journ. Jap. Bot. 16: 147 (1940).

This species is characterized by its 6–8-celled, (31–) 37.5–47.5 (–54.5) × 3.5–5 μm, dumbbell-shaped spores. It is corticolous.

Selected specimens examined: HUBEI, Shennongjia, 2250 m, 3.VII.1984, Chen JB, 10030. JIANGXI, Mt. Lushan, 3.IV.1960, Zhao JD et al., 573.

Literature records for China: HUBEI, JIANGXI (Jiang 1993, p. 73).

26. *Collema sichuanense* H.J. Liu & J.C. Wei, Mycosystema 22: 531 (2003).

Type(!): SICHUAN, Zoige County, Tiebu, 2800 m, 21.VI.1983, XY Wang & X Xiao, 10093 (HMAS-L). Paratype(!): SICHUAN, Aba, 3100 m, 28.VI.1983, XY Wang, 11343 (HMAS-L).

This species is characterized by 1) thallus foliose, lobes > 5 mm wide; 2) upper side regularly pustulate; 3) thallus and thalline exciple with pseudocortex; 4) proper exciple euthyplectenchymatous; 5) spores 6-celled, linear-fusiform, (27–) 30.5–37.5 (–44) × 3.5–5 µm. See Liu & Wei (2003b) for details.

LITERATURE RECORDS FOR CHINA: SICHUAN (Liu & Wei 2003b, p. 531).

27. *Collema subconveniens* Nyl., Lich. Nov. Zel.: 8 (1888).

= *C. tianmuense* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 84 (1992).

This species is characterized by its foliose thallus with broad lobes (> 5 mm wide) having a distinct pseudocortex on both sides, and its submuriform spores. It is corticolous or terricolous. See Liu & Wei (2003a) for details.

LITERATURE RECORDS FOR CHINA: HUBEI, YUNNAN (Liu & Wei 2003a, p. 357), SHAANXI (Liu & Wei 2003a, p. 357; Guo 2005, p. 47), XINJIANG (Abbas & Wu 1998, p. 62; Liu & Wei 2003a, p. 357; Guo 2005, p. 47).

28. *Collema subflaccidum* Degel., Symb. Bot. Upsal. 20(2): 140 (1974).

This species is characterized by 1) foliose thallus with > 5 mm wide lobes; 2) upper side without regular ridges or pustules; 3) globular to occasionally cylindrical isidia on the upper side; 4) spores 6-celled, fusiform, 34–57.5 × 3.5–8.5 (–13.5) µm. It is corticolous.

SELECTED SPECIMENS EXAMINED: BEIJING, Mt. Xishan, 12.X.1961, Zhao JD & Sun ZM, 5069. JILIN, Mt. Changbaishan, 20.VIII.1977, Wei JC, 3118. NEI MONGOL, Horqin Youyi Qianqi, 1200 m, 6.VII.1985, Gao XQ, 930. SHAANXI, Mt. Taibaishan, 2260 m, 10.VI.1963, Wei JC et al., 2589. ANHUI, Jinzhai, 650 m, 10.IX.2001, Liu HJ, 552. GUIZHOU, Mt. Fanjingshan, 1220 m, 19.VIII.1963, Wei JC, 300-1. JIANGXI, Mt. Tianchishan, 800 m, 12.II.1965, Wei JC, 3090. YUNNAN, Zhongdian, 3650 m, 22.VIII.1981, Wang XY et al., 7562. XINJIANG, Mt. Altay Shan, Abbas A, 200732.

LITERATURE RECORDS FOR CHINA: HEILONGJIANG (Chen et al. 1981a, p. 134; Wu 1987, p. 55), JILIN (Wu 1987, p. 55), SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47), XINJIANG (Guo 2005, p. 47), JIANGSU (Wu & Xiang 1981, p. 2; Wu & Qian 1989, p. 195; Wu 1987, p. 55), ANHUI, SHANGHAI, ZHEJIANG (Wu & Qian 1989, p. 195), JIANGXI (Degelius 1974, p. 140), FUJIAN (Wu et al. 1984, p. 1).

29. *Collema subnigrescens* Degel., Symb. Bot. Upsal. 13(2): 413 (1954).

29.1. f. *subnigrescens*

= *C. pulchellum* var. *multipartitum* Z.G. Jiang, Journal of Hebei Normal University (Natural Science) 16(3): 86 (1992) (p.p.).

This form differs from f. *caesium* in having apothecia without pruina. It is corticolous. See Liu & Wei (2003a) for details.

LITERATURE RECORDS FOR CHINA: SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47), HUNNAN, SICHUAN, XIZANG (Liu & Wei 2003a, p. 358).

29.2. f. *caesium* (Clemente) Degel., Symb. Bot. Upsal. 13(2): 417 (1954).***

This form is characterized by 1) thallus foliose, lobes > 5 mm wide; 2) upper side with regular ridges and pustules; 3) apothecia pruinose; 4) thalline exciple with pseudocortex; 5) proper exciple euthyplectenchymatous; 6) spores broadly acicular, 6-celled, (34–) 45–64 × (3.5–) 5–7 μm. It is corticolous.

Selected specimens examined: SICHUAN, Yanyuan, 3450 m, 26.VIII.1983, Wang LS, 83-1294 (KUN 6911). GUIZHOU, Mt. Fanjingshan, 1220 m, 19.VIII.1963, Wei JC, 300.

30. *Collema substipitatum* Zahlbr., in Handel-Mazzetti, Symb. Sin. 3: 76 (1930).

30.1. var. ***substipitatum***

This taxon resembles *C. leptaleum* and *C. shiroumanum* in external appearance (with subfoliose to crustose and fenestrate thallus, rugose upper side and < 5 mm wide lobes), but differs in having 6–10-celled, longer (> 40 μm long), fusiform to acicular spores.

Selected specimens examined: GUIZHOU, Daozhen, 1600 m, 15.VI.1987, Wu, 2933. SICHUAN, Mt. Emeishan, 2800 m, 18.VIII.1963, Zhao JD & Xu LW, 8017.

Literature records for China: YUNNAN (Zahlbruckner 1930, p. 76. Degelius 1974, p. 188); TAIWAN (Degelius 1974, p. 188).

30.2. var. ***gonggashanense*** H.J. Liu & J.C. Wei, Mycosystema 22: 532 (2003).

Type(!): SICHUAN, Mt. Gonggashan, Dongpo, Yanzigou, 2650 m, 2.VII. 1982, XY Wang et al., 8729-1 (HMAS-L).

This taxon differs from var. *substipitatum* in having a well developed euparaplectenchymatous proper exciple. See Liu & Wei (2003b) for details.

Literature records for China: SICHUAN (Liu & Wei 2003b, p. 532).

31. *Collema tenax* (Sw.) Ach., Lichenogr. Univ.: 635 (1810).

This species is distinguished by the marginally swollen and plicate lobes, euthyplectenchymatous proper exciple, and fusiform to ellipsoid, 4-celled to submuriform spores (15–28 × 6–10.5 μm). It is terricolous.

Literature records for China: HEILONGJIANG (Chen et al. 1981b, p. 150), SHAANXI (Wu 1987, p. 55; Guo 2005, p. 47).

The articles mentioned above recorded this species without indicating infraspecific taxa. In any case, var. *tenax* is not included here because it has not been found in the materials we have examined from China so far.

31.1. var. ***corallinum*** (A. Massal.) Degel., Symb. Bot. Upsal. 13(2): 165 (1974).

This variety is characterized by 1) thallus subfoliose to foliose, 2–3 cm diam.; 2) lobes < 2 mm wide, erect, often forming erect clusters. It is terricolous.

Selected specimens examined: NEI MONGOL, Xilinhot, Inner Mongolian Grassland Ecosystem Research Station of Academia Sinica, 1150 m, 27.VII.2003, Liu HJ, 751.

XINJIANG, Pishan, 3500 m, 13.VIII.1992, Abbas A, 92-0373-c [Abbas & Wu (1998) as *C. tenax* var. *substellatum*].

Literature records for China: NEI MONGOL (Degelius 1974, p. 49), GANSU (Magnusson 1944, p. 20; Degelius 1954, p. 183, 1974, p. 49), XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 63; Abbas et al. 2001, p. 363; Guo 2005, p. 47).

31.2. var. ***crustaceum*** (Kremp.) Degel., Symb. Bot. Upsal. 13(2): 164 (1954).

In general habit, this variety resembles *C. tenax* var. *vulgare*, but differs in having smaller thallus (< 1 cm diam.), narrower lobes (< 2 mm wide) and smaller apothecia (< 1.5 mm diam.).

Selected specimens examined: HUNAN, Mt. Hengshan, 700 m, 1.IX.1964, Zhao JD & Xu LW, 10047. XINJIANG, Tomort, 2900 m, 25.VII.1977, Wang XY et al., 553.

Literature records for China: HEBEI (Jiang 1993, p. 69), XINJIANG (Guo 2005, p. 47).

31.3. var. ***diffracto-areolatum*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 164 (1954).

This variety differs from other infraspecific taxa of *C. tenax* by the isidiate and areolate thallus.

Selected specimens examined: XINJIANG, Yecheng, 3000 m, 8.VIII.1992, Abbas A, 92-0293.

Literature records for China: HEBEI (Jiang 1993, p. 70), XINJIANG (Guo 2005, p. 47).

31.4. var. ***expansum*** Degel., Symb. Bot. Upsal. 13(2): 162 (1954).***

This variety is characterized by 1) thallus foliose, > 5 cm diam.; 2) lobes glossy, plane, often > 5 mm wide, with somewhat swollen and plicate margins; 3) thallus and thalline exciple without typical pseudocortex; 4) proper exciple euthyplectenchymatous; 5) spores fusiform to ellipsoid, 4-celled to submuriform, (13.5–) 17–24 (–27) × (7–) 9–13.5 μm.

It differs from all the other infraspecific taxa of *C. tenax* in the large thallus and glossy upper side.

Selected specimens examined: NINGXIA, Mt. Helanshan, 30.V.1984, Liu SR, 9.

31.5. var. ***ogatae*** (Zahlbr.) Degel., Symb. Bot. Upsal. 20(2): 47 (1974).

This variety is characterized by its foliose thallus with distinctly branched lobes and accessory lobules on the upper side.

Selected specimens examined: XINJIANG, Kuche, 2600 m, 23.V.1992, Abbas A, 92-0741; Aketao, 3000 m, 30.VII.1992, Abbas A, 92-024 [Abbas & Wu (1998) as *C. fuscovirens*].

Literature records for China: TAIWAN (Zahlbruckner 1933, p. 27; Degelius 1974, p. 47 & 49; Ikoma 1983, p. 59), XINJIANG (Guo 2005, p. 47).

31.6. var. ***substellatum*** (H. Magn.) Degel., Symb. Bot. Upsal. 20(2): 47 (1974).

This taxon differs from all the other infraspecific taxa of *C. tenax* in having long (15 mm long) and narrow (< 1 mm wide) lobes.

Specimen examined: XINJIANG, Baicheng, 2600 m, 21.V.1998, Wang XY, 6678-1.

Literature records for China: XINJIANG (Abbas et al. 1996, p. 12; Abbas & Wu 1998, p. 63; Abbas et al. 2001, p. 363; Guo 2005, p. 47), GANSU (Magnusson 1940, p. 41; Degelius 1974, p. 49).

31.7. var. ***vulgare*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 163 (1954).

This taxon is characterized by its radiating, narrow (1–4 mm wide), plane lobes.

Selected specimens examined: HEBEI, Mt. Xiaowutaishan, 2100 m, Jiang ZG, 3696-1. NEI MONGOL, Ergun Zuoqi, Awuni, 10.VIII.1985, Gao XQ, 1467. NINGXIA, Mt. Helanshan, 1300 m, 21.V.1961, Han SJ et al., 2013. XINJIANG, Aketao, 3000–3250 m, 30.VII.1992, Abbas A, A-B, 920023, 920025, 920030, 9200109 [the specimens mentioned above from Xinjiang were cited as *C. fuscovirens* by Abbas & Wu (1998) and Abbas et al. (1996)].

Literature records for China: XIZANG (Degelius 1974, p. 49), XINJIANG (Abbas et al. 1996, p. 12, as *C. fuscovirens*; Abbas & Wu 1998, p. 63; Guo 2005, p. 47).

31.7.1. f. ***papulosum*** (Schaer.) Degel., Symb. Bot. Upsal. 13(2): 163 (1954).

This form often grows together with var. *vulgare,* from which it differs mainly in having the numerous, dense and globular isidia on the upper side.

Selected specimens examined: HEBEI, Mt. Baihuashan, 900 m, 14.IX.1978, Wei JC & Jiang YM, 3501. XINJIANG, Kuche, 3200 m, 23.V.1992, Abbas A, 92-0767 [Abbas & Wu (1998) as *C. tenax* f. *vulgare*].

Literature records for China: HEBEI (Jiang 1993, p. 69), XINJIANG (Guo 2005, p. 47).

32. *Collema texanum* Tuck., Am. Journ. Arts & Sci., ser. 2, 28: 200 (1859).

The species is characterized by the foliose thallus with repeatedly furcate, convex, marginally swollen, narrow (< 2 mm wide) lobes. It grows on soil-covered rocks.

Specimen examined: YUNNAN, Kunming, 1780 m, 16.I.1981, Jiang YM, 1153-1.

Literature records for China: ZHEJIANG (Degelius 1974, p. 57).

33. *Collema undulatum* Laurer ex Flot., Linnaea 23: 161 (1850).

33.1. var. ***undulatum***

The variety is characterized by the foliose thallus with 2–4 mm wide, repeatedly furcate, somewhat concave and undulate lobes. It is terricolous.

Selected specimens examined: XINJIANG, Kuche, 3100–3500 m, 22–30.V.1992, Abbas A, 92-0426, 92-0800.

Literature records for China: SHAANXI, GUANGXI (Jiang 1993, p. 71), XINJIANG (Guo 2005, p. 47).

33.2. var. ***granulosum*** Degel., Symb. Bot. Upsal. 13(2): 369 (1954).

This variety differs from var. *undulatum* in having globular isidia on upper side. It is saxicolous or terricolous.

Selected specimens examined: NEI MONGOL, Horqin Youyi Qianqi, 1500 m, 9.VII.1985, Gao XQ, 937. SHAANXI, Mt. Taibaishan, 1300 m, VII.1992, Chen JB & He Q, 5614. JILIN, Mt. Changbaishan, 1850 m, 28.VIII.1984, Lu XD, 848390-1.

Literature records for China: NEI MONGOL, HEBEI (Jiang 1993, p. 71), SHAANXI (Guo 2005, p. 47).

Taxa excluded from China

1. ***Collema pulchellum*** var. ***leucopeplum*** (Tuck.) Degel.
Symb. Bot. Upsal. 20(2): 172 (1974).

This name has been used for specimens of three taxa, *C. complanatum*, *C. pulchellum* var. *pulchellum* and *C. pulchellum* var. *subnigrescens* (see specimen citation of each taxon for details). It was reported from Nei Mongol, Jilin, Heilongjiang, Shaanxi and Qinghai (Jiang 1993).

2. ***Collema latzelii*** Zahlbr., Österr. Bot. Zeitschr. 59: 493 (1909).

This species was reported from Hebei by Jiang (1993) based on a misidentified specimen of *C. poeltii* (see specimen citation for details).

Taxa not included in this study

The following taxa were previously recorded in China. Among them, three species described by Jiang (1992), *C. fanjingshanense*, *C. fusiosporum* and *C. tetrasporum*, are doubtful because the original descriptions are short, not very informative, and not consistent with the type material. Specimens of the other taxa listed below were not available for study and the reports, therefore, could not be verified.

1. ***Collema beijingense*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 84 (1992).

Literature records for China: BEIJING, HEBEI (Jiang 1992, p. 84).

2. ***Collema callibotry*s** var. ***coccophyllizum*** (Zahlbr.) Degel.,
Symb. Bot. Upsal. 20(2): 68 (1974).

Literature records for China: YUNNAN (Hue 1898, p. 217; Zahlbruckner 1930, p. 76).

3. ***Collema callopismum*** A. Massal., Miscell. Lich.: 23 (1856).

Literature records for China: HEBEI (Jiang 1993, p. 70).

4. ***Collema ceraniscum*** Nyl., Flora 48: 353 (1865).

Literature records for China: BEIJING, HEBEI (Jiang 1993, p. 70).

5. ***Collema clavisporiferum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).

Literature records for China: YUNNAN (Jiang 1992, p. 85).

6. ***Collema fanjingshanense*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 86 (1992).

Literature records for China: GUIZHOU (Jiang 1992, p. 86).

7. ***Collema fusiosporum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).

Literature records for China: YUNNAN (Jiang 1992, p. 85).

8. ***Collema limosum*** (Ach.) Ach., Lichenogr. Univ.: 629 (1810).

Literature records for China: SHANGHAI (Nylander & Crombie 1883, p. 62; Degelius 1974, p. 52).

9. ***Collema peregrinum*** Degel., Symb. Bot. Upsal. 20(2): 109 (1974).

Literature records for China: TAIWAN (Degelius 1974, pp. 109–111; Ikoma 1983, p. 59).

10. ***Collema sorediatum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 85 (1992).

Literature records for China: ANHUI, GUANGXI, SICHUAN (Jiang 1992, p. 85).

11. ***Collema tenax*** var. ***ceranoides*** (Borrer) Degel.,
Symb. Bot. Upsal. 13(2): 162 (1954).

Literature records for China: HEBEI (Jiang 1993, p. 69)

12. ***Collema tetrasporum*** Z.G. Jiang,
Journal of Hebei Normal University (Natural Science) 16: 84 (1992).

Literature records for China: BEIJING (Jiang 1992, p. 84).

13. ***Collema thamnodes*** Tuck. ex Riddle, Bull. Torrey Bot. Club 43: 155 (1916).

Literature records for China: XINJIANG (Abbas & Wu 1998, p. 64).

Acknowledgments

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Macromycetes of Kahramanmaraş Province (Turkey)

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Abstract —This study was based on the macrofungi specimens collected from Kahramanmaraş province of Turkey during 1999–2007 and 312 taxa were identified. Including the 25 taxa reported before, a list of 337 taxa belonging to 134 genera of 57 families has been compiled. Seven taxa are new records for the macromycota of Turkey. The complete list is available on http://www.mycotaxon.com/resources/weblists.html and http://web.adiyaman.edu.tr/~akaya/pub/maras.pdf.

Key words — biodiversity, mushrooms

Introduction

Kahramanmaraş is the eleventh largest vilayet of Turkey with a surface area of 14346 km^2. The province is placed at the intersection point of Mediterranean, Central Anatolian and East Anatolian regions and in squares B6 & C6 according to Davis' grid square system (Davis 1965). The geographical structure is composed mainly of the western foothills of the South Eastern Taurus Mountains and the valleys among them. The area has a Mediterranean climate according to Emberger's formula (Akman 1999) and falls in the Mediterranean and Irano-Turanian phytogeographical sectors within the holoarctic floral kingdom. The river Ceyhan, which arises in Kahramanmaraş and passes throughout the province, and the dams constructed on it are among the important hydrologic factors affecting the climate. Three main vegetation types can be distinguished in the study area. In altitude from 200 to 600 meters, maquis vegetation containing of the evergreen shrubs is developed. Depending on local climatic conditions, altitude and direction, forest vegetation occupies different zones from 400 to 1600 m. Steppe vegetation is dominant in plateaus (1000-1300 m) and hills above the timberline (1600 m).

Although taxonomic studies on Turkish macromycota have a history of about 90–100 years, substantial increase in the number of macrofungal contributions have been performed especially in last three decades and some checklists were published (Sesli & Denchev 2005, Afyon et al. 2005, Solak et al.

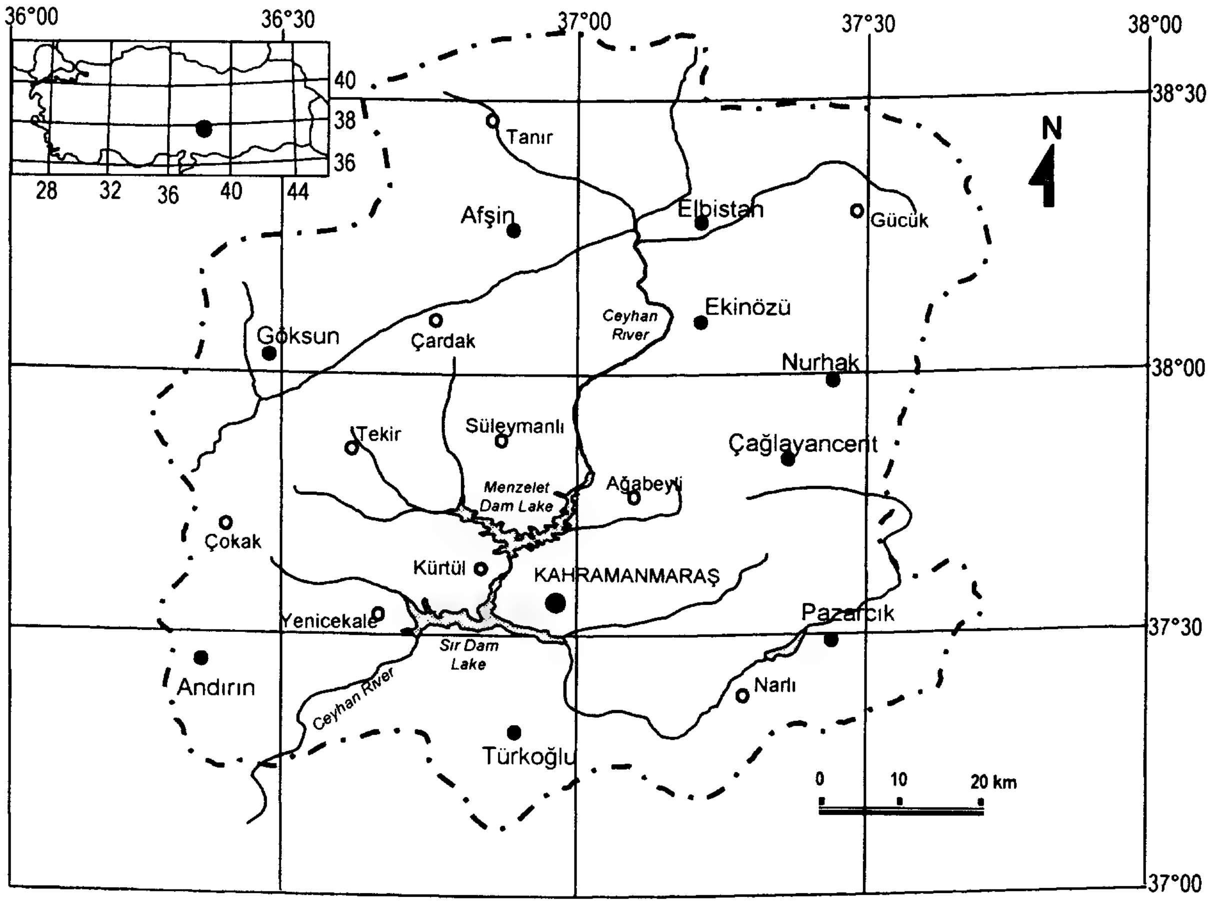

FIGURE 1. Map of the sampling area

2007). To date Kaya (2006) has carried out a local taxonomic study in Andırın district of Kahramanmaraş and some new records were given by Kaya et al. (2008). The current study was based on macrofungi specimens collected from the rest of the province together with the previously studied district, and aims to determine the macromycota of the region and provide more data on the macrofungi of Turkey.

Materials and Methods

The macrofungi samples were collected from 116 localities in Kahramanmaraş province of Turkey for a period of 9 years between 1999 and 2007. During field studies, macroscopic characteristics and field parameters of the specimens were recorded and color photographs were taken. Carrying them to the herbarium, macroscopic and microscopic investigations and micro-chemical reactions were carried out. Identification of the specimens was performed according to the relevant literature (Phillips 1981, Moser 1983, Miller & Miller 1988, Breitenbach & Kränzlin 1984–2005, Candusso & Lanzoni 1990, Buczacki 1992, Jordan 1995, Pegler et al. 1995, Bessette et al. 1997, Cappelli 1997, Antonín & Noordeloos 1997). The samples are deposited at Adıyaman University Education Faculty Adıyaman, Turkey.

Results

As a result of a 9-year investigation, 312 taxa were identified. The taxa are listed in alphabetical order. The systematics of the taxa are in accordance with Cannon & Kirk (2007), Kirk et al. (2008) and Index fungorum (www.speciesfungorum.org; accessed). For each taxon, habitat, collection date, locality and accession numbers (K) are given. The 25 taxa, found in the province and reported before (Kaya 2006), were also added to the list together with their references. Consequently, the checklist contains 337 taxa belonging to 134 genera and 57 families. The taxa included 25 *Ascomycota* (2 *Helotiales,* 22 *Pezizales,* and 1 *Xylariales*) and 312 *Basidiomycota* (231 *Agaricales,* 2 *Auriculariales,* 17 *Boletales,* 1 *Cantharellales,* 6 *Geastrales,* 1 *Gloeophyllales,* 4 *Gomphales,* 3 *Hymenochaetales,* 1 *Phallales,* 20 *Polyporales,* 18 *Russulales,* 5 *Thelephorales,* and 3 *Tremellales*). Seven taxa are new records for Turkey: *Gautieria monticola, Inocybe catalaunica, Lepiota kuehneri, L. roseifolia, Omphalina xylophila, Pseudoclitocybe obbata,* and *Russula cremeoavellanea.*

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Two records of *Ganoderma* new to mainland China

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Abstract — *Ganoderma applanatum* var. *laevisporum* and *Ganoderma multipileum* are first reported from mainland China. *Ganoderma chenghaiense* is found to be a synonym of *G. multipileum*. *G. applanatum* var. *laevisporum* is characterized by a rigid, sessile basidioma with a dull upper surface, yellow-brown to red-brown context, and smooth basidiospores 9.2–10.5 × 5.5–6.5 µm. *G. multipileum* is easily recognized by an orange-red to red-brown laccate pileus, pale brown to red-brown context, and finely echinulate basidiospores 9.2–10.0 × 6.2–7.0 µm.

Key words — distribution, East Asia, new record, polypore

Introduction

In a survey of species of the *Ganodermataceae* Donk reported from mainland China, two collections deposited in the Mycological Herbarium, Academia Sinica (HMAS), were of particular interest.

One collection from Guangxi was first identified as *Ganoderma applanatum* (Pers.) Pat. by Shu-Chun Teng, and later re-determined as *Ganoderma mirivelutinum* J.D. Zhao by Ji-Ding Zhao. Re-examination of this collection and comparison with the holotype of *G. mirivelutinum* designated in Zhao (1988) found that this collection from Guangxi is morphologically distinct from *G. mirivelutinum*, but identical to *Ganoderma applanatum* var. *laevisporum* based on the protologue in Humphrey & Leus (1931) and examination of one of two type collections of this variety.

The other collection from Guangdong is the holotype of *Ganoderma chenghaiense*. Re-examination of the types of *G. chenghaiense* in this survey

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and of *Ganoderma multipileum* in a previous study (Wang & Wu 2008) revealed that these two species are conspecific and the latter species has the priority of publication over the former.

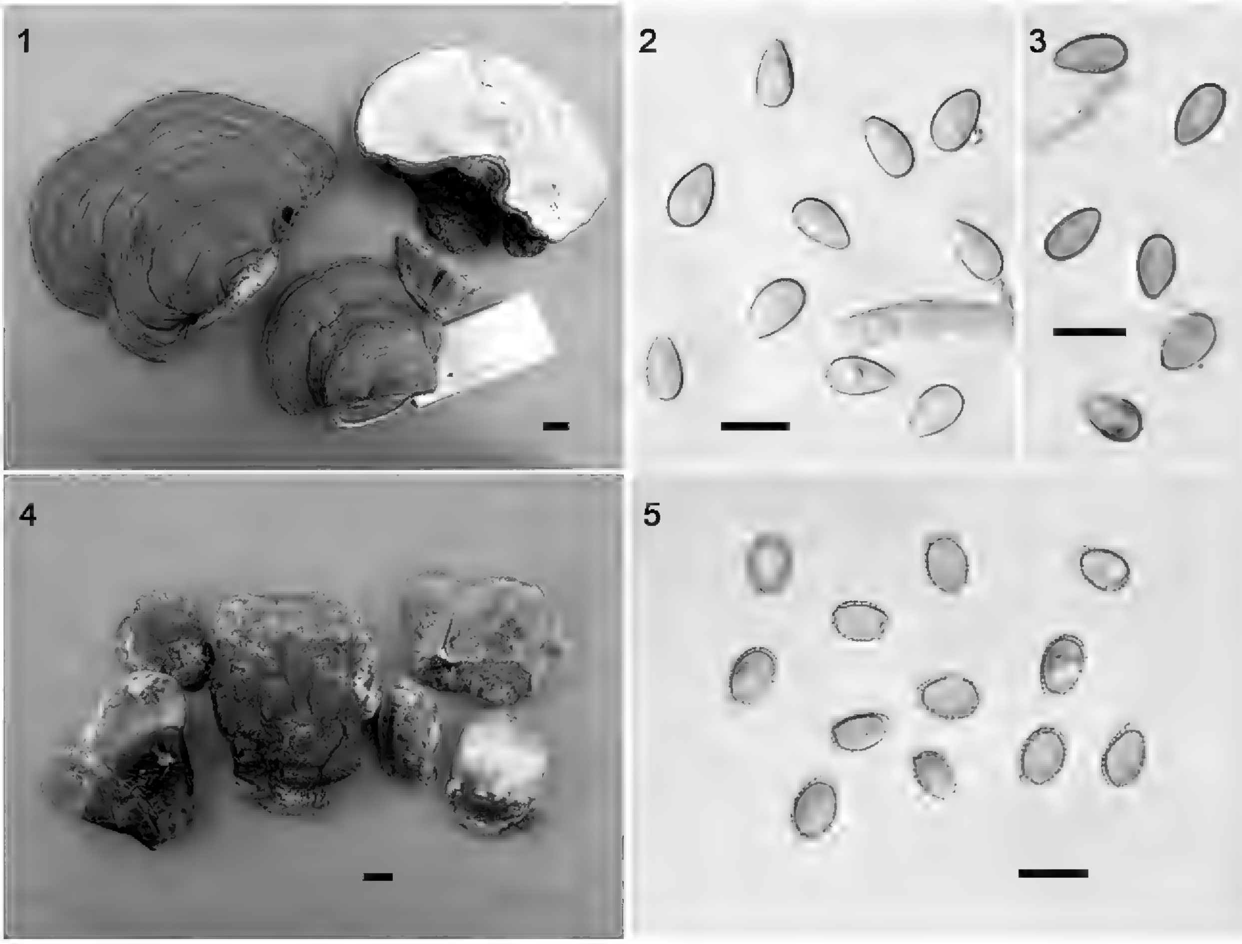
The methods for morphological studies mainly followed Wang & Wu (2007).

Taxonomy

Ganoderma applanatum **var.** ***laevisporum*** C.J. Humphrey, Philipp. J. Sci., C, Bot. 45: 533 (1931). FIGS. 1–3.

BASIDIOMA annual, sessile but with a slightly to distinctly contracted base, woody. PILEUS 4.5–7.0 × 6.2–10.5 cm, up to 3.5 cm thick at the base, pulvinate; upper surface grayish white to brown, dull, with narrow grooves or not; margin obtuse, lobate or not, concolorous. PORE SURFACE cream; tubes 1.5–9.0 mm long, yellow-brown; pores 5–6 per mm, circular or subcircular, 110–140 µm diam., dissepiments 30–70(–140) µm thick. CONTEXT 2.0–8.0 mm thick, yellow-brown to brown, tinged with whitened streaks or patches, corky; generative hyphae 2.5–4.5 µm diam., colorless, thin-walled, with clamp-connexions; skeleto-ligative hyphae 4.5–7.0 µm diam., yellow-brown to red-brown; binding hyphae *bovista*-type, 1.5–3.5 µm diam., colorless, solid, much-branched. BASIDIOSPORES 9.2–10.5 × 5.5–6.5 µm, ellipsoid or ovoid, apically non-truncate, lacking echinulation, dark brown. CUTIS composed of red-brown solid hyphae, and colorless thick-walled hyphae intertwined, dextrinoid.

SPECIMENS EXAMINED—**Mainland China: Guangxi**, Lingle county, Laoshan, on rotten wood, alt. 1700 m, 14 Dec. 1957, L.-W. Xu, 1240 (HMAS 20747; Originally identified as "*Ganoderma applanatum*" or "*Ganoderma mirivelutinum*"). **Taiwan: Chiayi**, Yushan National Park, Nanhsi Forest Road, 23°28′N, 120°54′E, alt. 1850 m, on trunk of living angiosperm, 13 Oct. 1993, S.-H. Wu & S.-Z. Chen, Wu 9310-26 (TNM F0001342; Originally identified as "*Ganoderma australe* (Fr.) Pat."); Yushan National Park, Nanhsi Forest Road, 23°28′N, 120°54′E, alt. 1800 m, on trunk of angiosperm, 13 Jun. 1996, S.-H. Wu & S.-Z. Chen, Wu 9606-45 (TNM F0005075; Originally identified as "*G. australe*"). **Hsinchu**, Between Chingchuan Checkup Post and Kuanwu, 24°32′N, 121°06′E, alt. 1400 m, on rotten trunk of angiosperm, 20 Nov. 1997, S.-Z. Chen, Chen 735 (TNM F0008859; Originally identified as "*G. australe*"). **Nantou**, Meifengshuiyuanti, 24°06′N, 121°10′E, alt. 2150 m, on rotten wood, 19 Feb. 1997, C.-C. Wen & S.-Z. Chen, CWN 02101 (TNM F0007463; Originally unnamed collection); Meifengshuiyuanti, 24°06′N, 121°10′E, alt. 2150 m, on rotten wood, 25 Apr. 1996, W.-N. Chou, CWN 01449 (TNM F0004942; Originally unnamed collection); Tsuifeng, 24°07′N, 121°12′E, alt. 2300 m, on stump of angiosperm, 16 Feb. 1993, S.-H. Wu, Wu 9302-56 (TNM F0001247; Originally identified as "*G. australe*"). **Taichung**, Anmashan, 24°16′N, 121°00′E, alt. 2250 m, on rotten trunk, 8 Nov. 1997, S.-H. Wu & H.-J. Chan, Wu 9711-43 (TNM F0009389; Originally identified as "*G. australe*"); Anmashan, 24°16′N, 121°00′E, alt. 2250 m, on rotten trunk of angiosperm, 8 Nov. 1997, S.-H. Wu & H.-J. Chan, Wu 9711-44 (TNM F0009993; Originally identified as "*G. australe*"); Anmashan, 24°16′N, 121°00′E, alt. 2100 m, on trunk of angiosperm, 6 Nov. 2003, S.-H. Wu et al., Wu 0311-3 (TNM



FIGS 1–3. *Ganoderma applanatum* var. *laevisporum*. FIG. 1. Basidiomata (HMAS 20747); FIG. 2. Basidiospores (HMAS 20747). FIG. 3. Basidiospores (PC 0096710). FIGS 4–5. *Ganoderma multipileum* (HMAS 50774). FIG. 4. Basidiomata; FIG. 5. Basidiospores.
Bars = 1 cm in F IGS. 1 & 4; = 10 µm in F IGS. 2, 3 & 5.

F0015693; Originally identified as "*G. australe*"). **The Philippines:** Luzon, Mountain Province, Bontoc Subprovince, Mt. Data, Mossy forest, Feb. 1928, M.S. Clemens (PC 0096710 = Bureau Of Science No. 50084, **Type**). The above description is solely based on the collection from mainland China. The type from The Philippines and collections from Taiwan are only used for the purpose of comparisons.

DISTRIBUTION—Java and Philippine Islands (Humphrey & Leus 1931), Taiwan (Chang 1994), Mainland China (this study).

NOTES—Humphrey & Leus (1931) proposed the variety, *G. applanatum* var. *laevisporum*, based on collections from Java (Tjibodas) and Philippine Islands (Luzon and Mindanao). Basidiospores with smooth inner and outer wall layers is a key diagnostic feature of this variety. Besides, the rigid, sessile basidioma with a dull upper surface, "Verona brown" (Ridgway) to "auburn" (Ridgway) or "bay" (Ridgway) context, and a distribution at higher elevations in the tropics or subtropics are also important features for identification. The Chinese collection cited above is considered to conform with these characters. Furthermore, its basidiospores (9.2–10.5 × 5.5–6.5 µm) are very close in size to those of the type collection of *G. applanatum* var. *laevisporum* PC 0096710 (9.3–10.3(–10.8) × 5.4–5.9(–6.4) µm) measured in this study.

Steyaert (1972) regarded *G. applanatum* var. *laevisporum* as a synonym of *Ganoderma tornatum* (Pers.) Bres. He found that smooth-walled spores can be observed in many species of *Ganoderma*, and their abundance may vary considerably from a small percentage to a majority of spores. His re-examinations of two collections cited by Humphrey & Leus (1931), part of Bureau of Science 50084 (one of two designated types) deposited in Paris and BO 705 from Java, showed that the Paris type (50084) has only a few echinulate spores in tube layer sections while the Javanese collection (BO 705) comprises two basidiomata, one lacking spores and the other with only echinulate spores. However, Humphrey & Leus (1931) proposed *G. applanatum* var. *laevisporum* based only on those specimens with smooth-walled spores, while observing echinulate spores in part of basidiomata of two of the collections cited in the protologue. We observed only smooth-walled spores (Fig. 3) from fragments of the type collection 50084 (= PC 0096710) that was studied by Steyaert (1972). Furthermore, a previous study of nine *G. applanatum* var. *laevisporum* collections from different localities in Taiwan revealed that smooth walls are a constant character, and the ITS sequences from three of those Taiwanese collections (data not shown) support the taxonomic position of this variety. Therefore, the present authors consider that *G. applanatum* var. *laevisporum* represents a distinct taxon that is independent of *G. tornatum*.

G. applanatum var. *laevisporum* also produces a perennial basidioma with a larger (12.0 × 12.5 cm) pileus and slightly longer (up to 11.0 µm) basidiospores in the Taiwanese collection Chen 735 (TNM F0008859). This taxon has been found on dead hardwoods (Chang 1994) or *Pinus insularis* (Humphrey & Leus 1931).

Zhao (1988) stated that *G. mirivelutinum* is characterized by the "flaskform velvet" on the upper surface of the pileus, formed from very numerous brownish thick-walled clavate cells. The collection from Guangxi HMAS 20747 has a pilear surface of distinct cuticular composition.

Ganoderma multipileum Ding Hou [as '*multipilea*'],
Q. J. Taiwan Mus. 3: 101 (1950). Figs. 4–5.
=*Ganoderma chenghaiense* J.D. Zhao, Acta Mycol. Sin. 8(1): 31 (1989).

Basidioma annual, sessile, corky. Pilei solitary or growing together, 3.8–5.0 × 5.0–6.2 cm, flabellate, or irregularly shaped; upper surface orange-red to red-brown, weakly to strongly laccate, non-sulcate, with fine wrinkles; margin thin, straw-yellow to orange-red. Pore surface yellow-brown; tubes up to 1.0 mm long, greyish brown; pores 6–7 per mm, mostly irregularly shaped, rarely circular or oblong, 70–150 µm diam., dissepiments 40–50 µm thick. Context 0.2–1.0 cm thick, pale brown to red-brown, with black crustose layer

in some basidiomata, corky; generative hyphae 3.5–5.0 µm diam., colorless, thin-walled, with clamp-connexions; skeleto-ligative hyphae 4.5–7.5 µm diam., yellow-brown to red-brown; binding hyphae *bovista*-type, 2.2–3.0 µm diam., colorless, thick-walled, much-branched. Basidiospores 9.2–10.0 × 6.2–7.0 µm (with myxosporium), 7.5–8.5 × 4.8–6.2 µm (without myxosporium), ovoid or ellipsoid, apically truncate or not, brown, with a dark brown eusporium with fine echinulae. Cutis composed of clavate elements, 25–40 × 6.5–12.0 µm, dextrinoid to slightly amyloid.

Specimens examined—**Mainland China: Guangdong**, Chenghai county, Oct. 1982, C.-J. Lin, 154 (HMAS 50774; Holotype of *Ganoderma chenghaiense*). **Taiwan: Taichung**, By Taichung Park, on stump, 7 Sep. 1949, Y.-F. Yu (TAIMF000001; Holotype of *Ganoderma multipileum*). The above description is solely based on the collection from mainland China. The collection from Taiwan is only used for the purpose of comparisons.

Distribution—Taiwan (Hou 1950, Wang & Wu 2008), Mainland China (this study).

Notes—Hou (1950) published *Ganoderma multipileum* based on a single collection from the lowlands in Taichung, Taiwan. This species has been recorded on the base or root of *Acacia confusa* (Chang & Chen 1986), and on the trunk of *Delonix regia* (Wang & Wu 2008). As suggested by the epithet "*multipileum*", Hou (1950) considered the multiple-pileate feature important in taxonomy. However, this characteristic is not reliable, as proved in the cultivation test of this species (Chang 1983). The most reliable criteria for recognizing *G. multipileum* are the basidiospore with fine echinulae, the orange-red to red-brown laccate pileus, pale brown to red-brown context, and the subtropical lowland distribution.

Zhao (1989) concluded that the features of a mostly tuberculate basidioma, and an irregularly shaped pileus are diagnostic of *G. chenghaiense*, when describing it as a new species. Furthermore, he mainly used the same characteristics to distinguish *G. chenghaiense* from another subtropical species, *Ganoderma tropicum* (Jungh.) Bres. However, basidiomatal appearance is taxonomically unreliable for *Ganoderma* species. *G. tropicum* differs from *G. chenghaiense* in having ovoid to broadly ovoid basidiospores with thick echinulae and a different ITS sequence (data not shown). *G. chenghaiense* is concluded to be synonymous with *G. multipileum* based on the finely echinulate basidiospores, along with other diagnostic features, e.g. pilear color, context color, and geographic distribution.

The holotype of *G. chenghaiense* comprises several basidiomata. They are immature, as indicated by having an incompletely developed pilear cuticle, or lacking hymenium. The type collection of *G. multipileum* also has incompletely developed basidiomata, but with slightly larger basidiospores, up to 12.0 µm long and 7.5 µm wide. The sizes of basidiospore and cuticle cells in mature collections might be larger than those measured in this study.

Acknowledgements

The authors are grateful to Drs. Tsutomu Hattori and Peter Buchanan for serving as pre-submission reviewers and for their valuable comments and suggestions. Thanks are also due to Dr. Bart Buyck, the curator of PC for the loan of type of *Ganoderma applanatum* var. *laevisporum*, and Dr. Yi-Jian Yao, the curator of HMAS for arranging loan of the *Ganodermataceae* specimens and for providing facilities for morphological work by the senior author in Beijing. This study is supported by the Natural Science Foundation of Guangdong Province, China (8451007002001904, E05202480), Science and Technology Planning Project of Guangdong Province, China (2008B020400013), and the Foundation of Guangdong Academy of Sciences, China for 2008 Outstanding Young Science and Technology Talents. The senior author also appreciates the financial support of the National Museum of Natural Science and Foundation of the National Museum of Natural Science, and Postdoctoral Fellowship Grant of National Science Council (NSC96-2816-B-178-001) for her work on the *Ganodermataceae* in Taiwan.

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MYCOTAXON

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Hypholoma tuberosum, a new representative of the Czech and Central-European mycobiota

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Abstract — *Hypholoma tuberosum* (*Basidiomycetes*, *Strophariaceae*) has been found in the Czech Republic for the first time, and this collection also represents the first well-documented record in Central Europe. Detailed macro- and microscopic descriptions are given and its world distribution is summarised. The sequencing of ITS and LSU region of nuclear ribosomal DNA confirmed the identity of the species.

Key words — *Basidiomycota*, taxonomy, ribosomal DNA

Introduction

During the excursion to the Hostýnské vrchy hills (Czech Republic, NE Moravia) organised by the second author, an interesting, brightly coloured fungus belonging to *Strophariaceae* was found. It was preliminarily identified as *Hypholoma tuberosum*. However, in 2007, it was collected without a sclerotium and so the species was not fully verified. Collection of many sclerotia during the 2008 season definitely confirmed our earlier identification. Our identification was also supported by the sequencing of ITS region of nuclear ribosomal DNA.

Material and methods

Macroscopic description based on fresh basidiocarps is made by the first author. Microscopic features are described from dried material mounted in

H_2O, c. 3 % KOH, Melzer's reagent and Congo Red using an Olympus BX-50 light microscope with a magnification of ×1000. For basidiospores, the factors E (quotient of length and width in any one spore) and Q (mean of E-values) are used. Authors of fungal names are cited according to Kirk & Ansell (1992) and colour abbreviations follow Kornerup & Wanscher (1983). Herbarium specimens are preserved in the herbarium of the Moravian Museum, Dept. of Botany, Brno, Czech Republic (BRNM).

DNA was extracted from the dried fungal material, using PowerSoil™ DNA Isolation Kit (Mo-Bio). The DNA was amplified with PCR, using the Mastercycler® ep thermocycler (Eppendorf). The PCR amplifications were performed according to Tomšovský et al. (2006), the purification of PCR products and sequencing were done according to Tomšovský & Ryvarden (2008).

Results

Hypholoma tuberosum Redhead & Kroeger, Mycotaxon 29: 457. 1987. FIGS 1–2.

Syn. *Psilocybe tuberosa* (Redhead & Kroeger) Walleyn, Sterbeeckia 18: 11. 1998.

Description of collected basidiocarps

BASIDIOCARPS single or in small groups (Fig. 1). PILEUS 15–45 mm broad, (broadly) conical, with ± obtuse, often distinct umbo at centre, slightly depressed around it, with inflexed to involute, then straight margin, sparsely radially squamulose in external half, especially at margin when young, soon glabrescent, entirely glabrous when old, connected with stipe by greyish or dirty whitish arachnoid velum, later ± without remnants at margin, never translucently striate, subviscid when moist, greyish orange to brownish orange (6B6–7, 6–7C7), paler, sometimes almost whitish towards margin. LAMELLAE moderately close, L = 28–32, l = 4–5, emarginate and attached with short tooth, greyish brown (± 6–7E2–3), paler when young, with whitish or white, finely denticulate and pubescent edge; yellow colour translucent among lamellae and lamellae becoming yellowish close to margin in old specimens. STIPE 25–55 × 2.5–4 mm, cylindrical, slightly broadened at apex, fusoid at base (up to 8 mm) and continuing to up to 60 mm long, towards base tapering pseudorhiza, striate, finely fibrillose and distinctly flocculose at apex, distinctly longitudinally fibrillose towards base, finely fibrillose-squamulose (velar remnants) at base in young specimens, those squamules ascending almost up to annulus in older specimens, whitish at apex, basal squamules concolorous with pileus but paler on greyish orange (5B4–5) ground; with brownish basal fibrils. Annulus in upper 1/3 to 1/5, less distinct, fibrillose, dirty white or greyish, then black from spores, soon only in the form of fibrillose zone. CONTEXT rather thick, whitish to yellowish in pileus centre, hollow and dirty whitish in stipe, without

Fig. 1. *Hypholoma tuberosum*. Basidiocarps. Photo: J. Burel (larger photo) and V. Antonín (inset)

distinct smell, taste bitterish or mild with bitter aftertaste. Sclerotium hard, irregularly tuberculate-lobate, up to 50 mm large, dark brown-black when fresh and moist, becoming grey-brown when dry, with homogenous, watery (grey-) yellow-brown context, shallowly under soil surface; mostly 1–2(3) basidiocarps grow from one sclerotium. Spore print purple brown.

Basidiospores 10.5–13(–14) × 5.5–7.0 µm, average = 11.7 × 6.2 µm, E = 1.6–2.1, Q = 1.6–1.8, fusoid, ellipsoid-fusoid, thick-walled (walls up to 0.5(–0.75) µm), with up to 1.5 µm large apical germ pore, smooth; wall brown in KOH. Basidia 27–34 × 8.5–11 µm, 4-spored, clavate, constricted at centre. Basidioles 15–34 × 6.0–11 µm, clavate to utriform, sometimes centrally constricted. Trama hyphae cylindrical to subinflated, ± thin-walled, hyaline, non-dextrinoid, up to 12 µm wide. Lamellae edge sterile. Cheilocystidia 23–40 × 6.5–8.5(–10) µm, fusoid, (sub)lageniform, utriform, rarely clavate, often broadly rostrate, sometimes subcapitate, thin-walled, with frequently thick-walled (up to 1.0 µm) apex, often with gelatinous cap and with crystals there. Chrysocystidia (pleurocystidia) 45–50 × (10–)12–18 µm, fusoid, thin-walled, with central to basal yellow (KOH) and yellow-brown (Melzer´s reagent) contents. Pileipellis a cutis of cylindrical, slightly thick-walled, incrusted (zebroid), up to 10 µm wide hyphae with brightly yellow-brown walls and incrustation in KOH; terminal cells adpressed to erect, clavate, cylindrical, sometimes subcapitate,

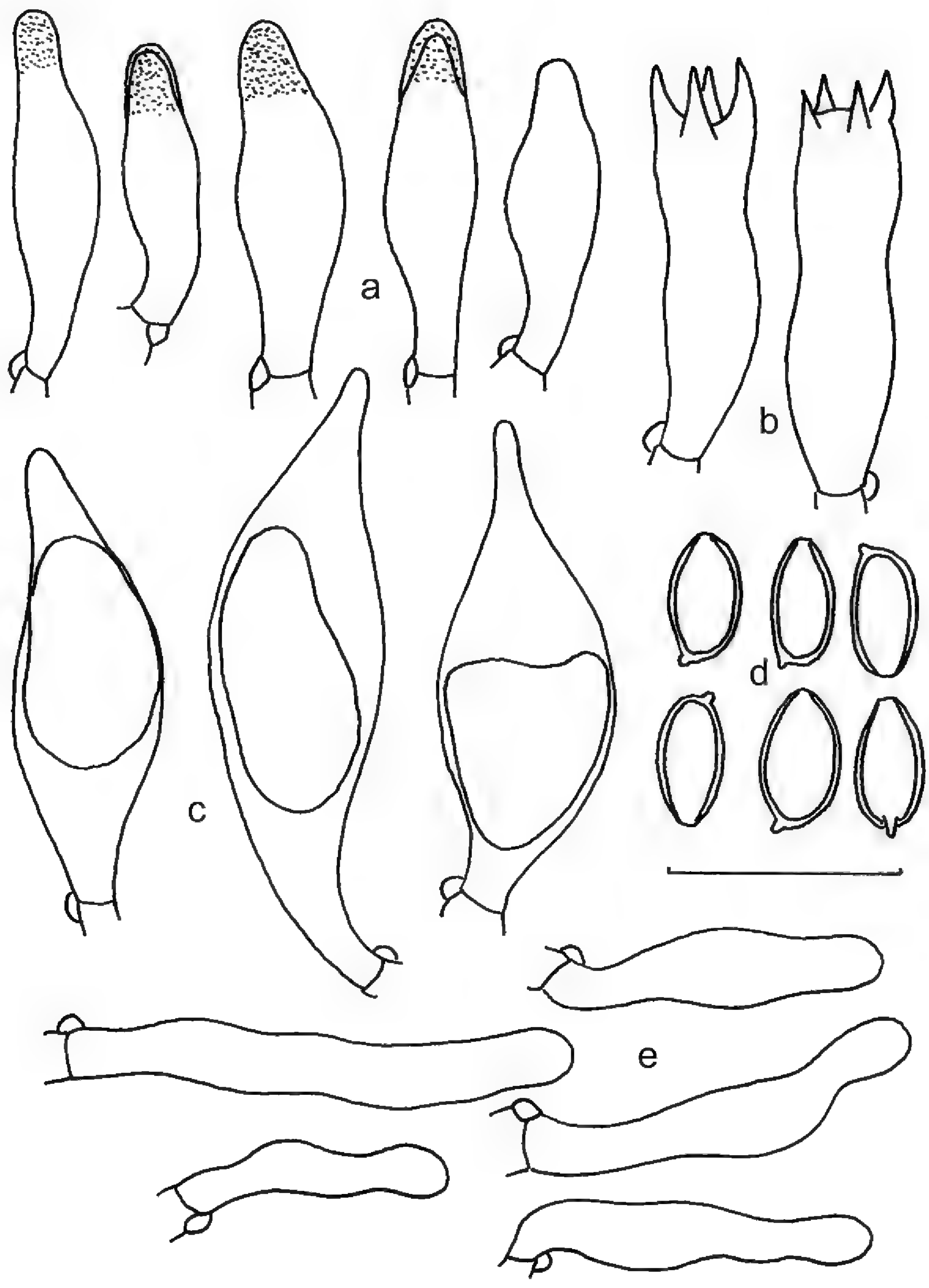

Fig. 2. *Hypholoma tuberosum*.
a. cheilocystidia, b. basidia, c. chrysocystidia, d. basidiospores, e. caulocystidia.
Scale bar = 20 µm.

± thin-walled; subpellis of (sub)globose to ellipsoid, smooth or incrusted cells. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, non-dextrinoid, up to 5.0 µm wide hyphae. Caulocystidia (apex) (24–)30–52 × 5.0–9.0 µm, numerous, cylindrical, clavate, subfusoid, (sub)lageniform,

subutriform, sometimes slightly irregular, subcapitate or rostrate, slightly thick-walled. Annulus of cylindrical, non-dextrinoid, hyaline to pale yellowish (KOH), smooth hyphae. Sclerotium of irregular, branched, thick-walled (up to 1.5 μm), hyaline to pale yellowish, up to 15 μm wide hyphae; terminal cells mostly irregular. Clamp-connections present in all tissues.

Habitat — On soil mixed with wooden chips and sawdust of *Fagus sylvatica* in an insulated open-air place at a depository close to a former charcoal production site along a road (the same place as the type locality of *Bolbitius psittacinus*; Hausknecht et al. 2007).

Locality — Czech Republic, Moravia, Hostýnské vrchy hills, Hošťálková, near Bernátka gamekeeper's lodge, 49° 21' 07" N, 17° 47' 25" E, alt. 550–560 m, 2 Sept. 2007 leg. J. Polčák et al. (Antonín 07.216: BRNM 710220). – Ibid., 31 Aug. 2008 leg. J. Polčák et al. (Antonín 08.178: BRNM 710221).

Molecular data — The obtained ITS and LSU sequences were compared to data deposited in the NCBI database using the BLAST (Altschul *et al.* 1990). The ITS sequence shows 99 % identity to sequence of *H. tuberosum*, accession no. EU682414 (He et al., unpublished) while the LSU sequence is similar (sequence identity of 98–99 %) to those of various strophariolid fungi (e.g. *Phaeonematoloma myosotis, Hypholoma marginatum, Stropharia semiglobata, S. umbonescens, Pholiota squarrosa).* Nevertheless, the LSU sequence of *H. tuberosum* was not accessible in the database during the preparation of this manuscript (2 Jan. 2009).

The newly obtained ITS and LSU sequences were deposited to the NCBI under accession numbers FJ461624 and FJ461623 respectively.

Remarks — *Hypholoma tuberosum* is characterised by having an orange-brown pileus, a deeply radicating stem, rather large basidiospores, well-developed cheilo- and chrysocystidia and especially by a well-developed sclerotium.

Characters of our collections agree well with the original description (Redhead & Kroeger 1987) except for slightly longer basidiospores (9.5–11.5 (–12.8) × 5.2–7.0(–7.8) μm in the original description). For the detailed discussion about other *Strophariaceae* species forming sclerotia see Redhead & Kroeger (1987). This species is also included in the key and descriptions of Flora Agaricina Neerlandica (Noordeloos 1999) although it was not known from the Netherlands at that time.

Walleyn (1998) accepted the generic conception of Noordeloos (1995, 1999) and transferred this taxon to the genus *Psilocybe* as *P. tuberosa*.

Hypholoma tuberosum, originally described from British Columbia, Canada, has also been collected on several localities in the U.S.A. (New York, Anonymous 2007b; California, Wood & Stevens 2008; Washington, Oregon, Anonymous 2007a). However, it also has been found in Asia (Japan, four localities, Nagasawa et al. 2000; and China, Sichuan province, He & Liu 2008),

Australasia (Australia, Sydney, Priest & Simpson 1992; and New Zealand, Mid Canterbury, Lincoln, Anonymous 2008). In Europe, it has been collected in two localities in Belgium (Namur and Gent, Noordeloos 1999, Walleyn 1998) for the first time. The third European record is from the Netherlands (Huijser pers. comm.). According to the internet page of the Pilzfreunde Chemnitz e.V. (Germany; http://www.pilzfreunde-chemnitz.de/ pilzkartierung.html), it was also recorded in the Chemnitz region already in 2002. Therefore, this Czech collection represents the fourth (or fifth) European and the first (or second) Central-European locality. It was collected in 2006 for the first time by the second author at the locality mentioned above. Since 2006, the fungus fruits regularly there forming numerous basidiocarps.

This species is connected to ruderal or strongly disturbed biotopes. Originally, it was described from compost piles, rank grass, mulched gardens, and loose soil extensively burrowed by mammals in park in Vancouver, Canada (Redhead & Kroeger 1987). In Japan (Nagasawa et al. 2000) it was found on fertilised soil in a cultivated field, lawns and parks. In Belgium and the Netherlands, it grew on soil mixed with *Populus* wooden chips (Huijser pers. comm., Walleyn 1998). Also the Czech locality is strongly influenced by man. It is a wood depository close to a former charcoal production site along a road where *Hypholoma tuberosum* grows on a forest soil mixed with remnants of wood and sawdust.

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A new species of *Alternaria* on *Humulus scandens* from China

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Abstract—A new species of the genus *Alternaria*, *A. humuli-scandens*, on *Humulus scandens* is reported. *A. humuli-scandens* is the first large-spored *Alternaria* species with long filiform rostra reported on plants of *Cannabaceae*. *A. humuli-scandens* is different from all the known species in the genus *Alternaria* based on the morphology and pathogenicity. The type specimen is deposited in the Herbarium of Henan Agricultural University: Fungi (HHAUF).

Key words—taxonomy, hyphomycetes, leaf spots, *Humulus japonicus*

In the course of a survey of mitosporic fungal pathogens of important weeds in China, a new taxon of *Alternaria* was found on *Humulus scandens* [= *Humulus japonicus* Siebold & Zucc.] in Henan Province. It is described as follows.

Alternaria humuli-scandens Meng Zhang, H.Y. Wu & Dong X. Li, **sp. nov.**

Mycobank # MB 512829 FIG. 1, PLATE 1

Conidia solitaria, obclavata vel ovoidea, recta, laevia, pallide brunnea, septa transversa 5–8, septa longitudinalia vel obliqua 2–6, constricta, 47–75 × 14–20.5 μm, rostrum septata, hyalina, 117–195 μm longum, e basi 3–5 μm ad apicem 2 μm diam.

Holotype: HHAUF $_{06}$0529=ZM$_{06}$0529 [dried cultures on PCA, isolated from leaf spots of *Humulus scandens* (Lour.) Merr.: Zhengzhou, Henan Province, 2006, Coll. Dong X. Li and H.Y. Wu].

Leaf spots irregular, brown, 5–12 mm in diameter. Colonies on PCA grayish-brown, velvety, effuse, sporulating freely. Conidiophores arising singly, terminally or laterally from hyphae, simple, straight or curved, smooth-walled, septate, pale brown, 55–75 × 7–8 μm. Conidia solitary, obclavate or ovoid, base obtuse, straight, pale brown, smooth-walled, with 5–8 transverse septa and 2–6 longitudinal or oblique septa, constricted at some main septa, 47–75

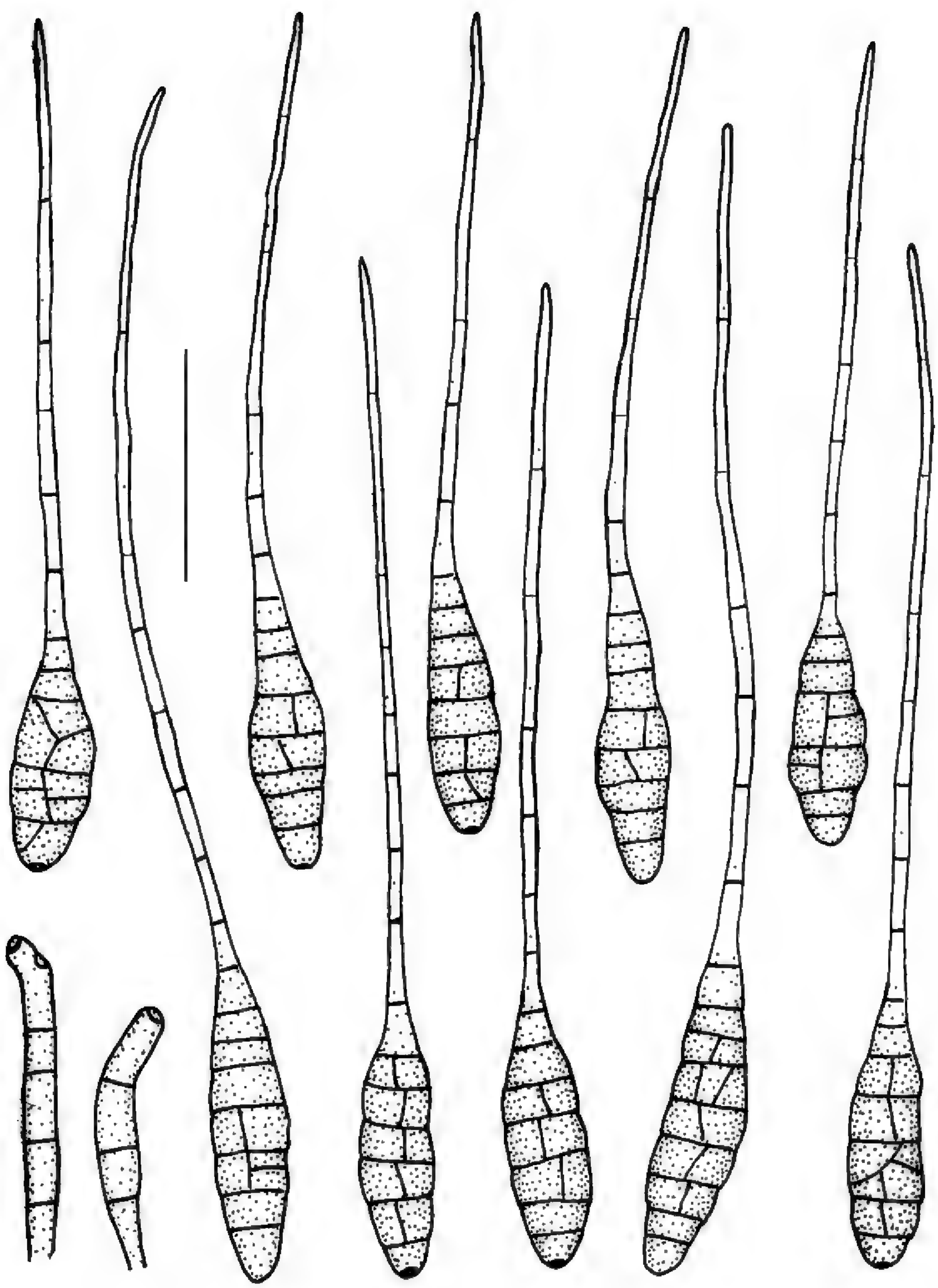

FIGURE 1. *Alternaria humuli-scandens*
Conidia and conidiophores on PCA. (ex holotype, bar=50µm)

× 14–20.5 µm. The tapering rostra are 117–195 µm long, ca 3–5 µm wide at the base, narrowing throughout most of their length to ca 2 µm, filiform, straight, septate, hyaline.

COMMENTS: Commonly large-spored *Alternaria* species are host specific in family; host ranges can be one of the identification criteria. Up to now, only

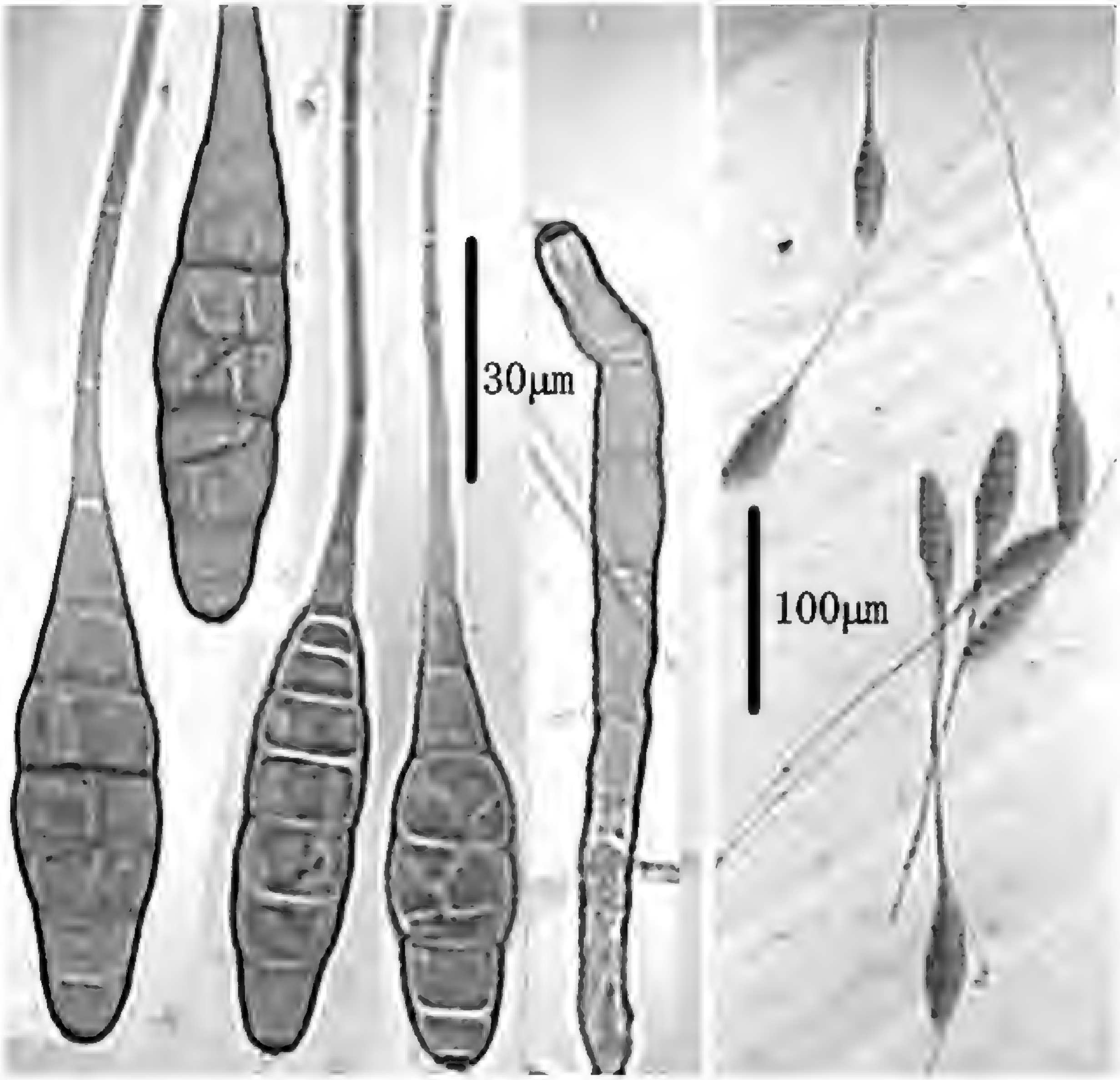

Plate 1 *Alternaria humuli-scandens*
Conidia and conidiophores on PCA. (ex holotype)

Alternaria humuli E.G. Simmons (a small-spored species) has been reported on plants of *Cannabaceae* (Simmons 2002, 2007). *A. humuli-scandens* is the first large-spored *Alternaria* species with long filiform rostra reported on this family. Compared to other species of *Alternaria* on the related host family *Moraceae*, *A. humuli-scandens* is close to *Alternaria fici* Farneti in size range of conidium bodies, but the conidia of the latter have beaks that are short or lacking entirely, while the conidia of *A. humuli-scandens* have long filiform rostra (Farneti 1904, Zhang et al. 2003).

Acknowledgments

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Two new African *Pulveroboletus* with ornamented spores

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Abstract — Two new bolete species, *Pulveroboletus bembae* and *P. luteocarneus*, are described from the rain forest of Gabon. Both are characterized by basidiospores with a similar rough structure.

Key words — *Boletales*, taxonomy

Introduction

Pulveroboletus was created by Murrill (1909) and is typified by *Boletus ravenelii* Berk. & M.A. Curtis. One hundred years later the circumscription of the genus remains controversial. *Pulveroboletus* is an essentially tropical or subtropical genus with velangiocarpic basidiomes producing an olivaceous brown spore deposit. The velar layers are pulverulent and detersile, sometimes viscid when moistened, and consist of narrow and encrusted hyphae (Pegler & Young 1981).

Singer (1962) greatly extended the concept of *Pulveroboletus* in a way Corner (1972) found confusing. In fact, most of the species added by Singer to the genus have no veil at all, not even a marginal one, and are characterized by a gelatinization of the epicutis. According to Corner, the continuity between the type species (*P. ravenelii* (Berk. & M.A. Curtis) Murrill) with a fibrillose, pulverulent-arachnoid veil, and the other sections is unclear, and the diagnostic characters are not sufficient to separate *Pulveroboletus* from subgen. *Boletus* (Corner 1972: 10). Singer replied to Corner's contention by underlining that *P. umbilicatus* (Massee) Singer—with a dry piloso-fasciculate tomentum when young turning mucilaginous with age—could be considered as the transition from the dry to the glutinous species (Singer 1986: 772). He then confirmed the seven sections he previously defined within the genus.

Until now, 12 species of *Pulveroboletus* are described in tropical Africa, mostly from DR Congo (Heinemann 1951, 1964). Six additional taxa collected

in the miombo woodland of DR Congo (Heinemann 1964) and Zambia (Watling & Turnbull 1992) remain unnamed.

Materials and methods

The macroscopic descriptions are based on field notes and photographs taken by the first author. Codes (between square brackets) and names for colours correspond to the Methuen Handbook of Colour (Kornerup & Wanscher 1983).

The microscopic structures were observed in Melzer's reagent as well as in congo-red ammonia. Measurements were performed using an Olympus BX51 light microscope, with digital camera and AnalySIS® Five imaging software (Soft Imaging System GmbH). Mean values (in italics) ± 1.96 × standard deviations, and minimum-maximum values (between brackets) are given for all microstructures and derived parameters (length/width ratios). For the statistical data the number N of basidiospores, basidia, and cystidia that were measured is given (between braces). For the analysis with the scanning electron microscope (SEM), small parts of the tubes were taken from the exsiccata. They were pretreated for 12 hours in water and ammonia. After a period of 1 hour in 70% ethanol, they were passed twice for 30 minutes in dimethoxymethane, before being submitted to the process of critical point drying. The samples were sputter-coated with gold (using Argon-gas, under 0.05 mbar) for 3.5 hours, until a layer of approximately 15 nm was obtained. The scanning electron microscopy was then carried out with a JEOL 5800 LV with a tension of 25 kV and working distance of 10–12 mm. Digital SEM-images were captured using Orion V (vers. 5.22) Image Management System. The holotype material and the additional collections are deposited at the National Botanic Garden of Belgium's herbarium 'BR' (abbreviation following Holmgren et al. 1990).

Taxonomy

Pulveroboletus bembae Degreef & De Kesel, **sp. nov.** FIGURES 1–3
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Pileus 30–35 mm, convexus dein convexo-planus, interdum subumbonatus, concolor badius ad brunneo-ferrugines, siccus, levis vel impolitus dein aliquantum conluceus; margine praeter pallidus, cum velamine, levi dein rimuloso. Tubi 4–5 mm, adnati, depressi ad stipitem, subventricosi, pallido-flavi, immutabiles. Pori angulares vel rotundi, denique 1 mm, concolores, griseo-flavi vel subpallidi, immutabiles. Stipes 37–55 × 4–5 mm, cylindricus, ad basim angustior 2–4 mm, solidus dein subfistulosus, impolitus, siccus, pallido-brunneus, vix subfurfuraceus, cum minusculis squamulis badiis tectus; mycelium basale flavum. Caro crassa, sufflava, virgata badia, pallido-brunnea in basim stipitis, immutabilis. Annulus levis, tenuis, praeter ad stipitem vel marginem pilei, ephemerus, albus. Basidiosporae (9.3–11.3 × 3.9–4.7 µm) subfusiformes vel boletiformes, scruposae, inamyloideae. Basidia (26.9–39.3 × 9.0–12.0 µm), cylindrica vel subclavata, tetraspora.

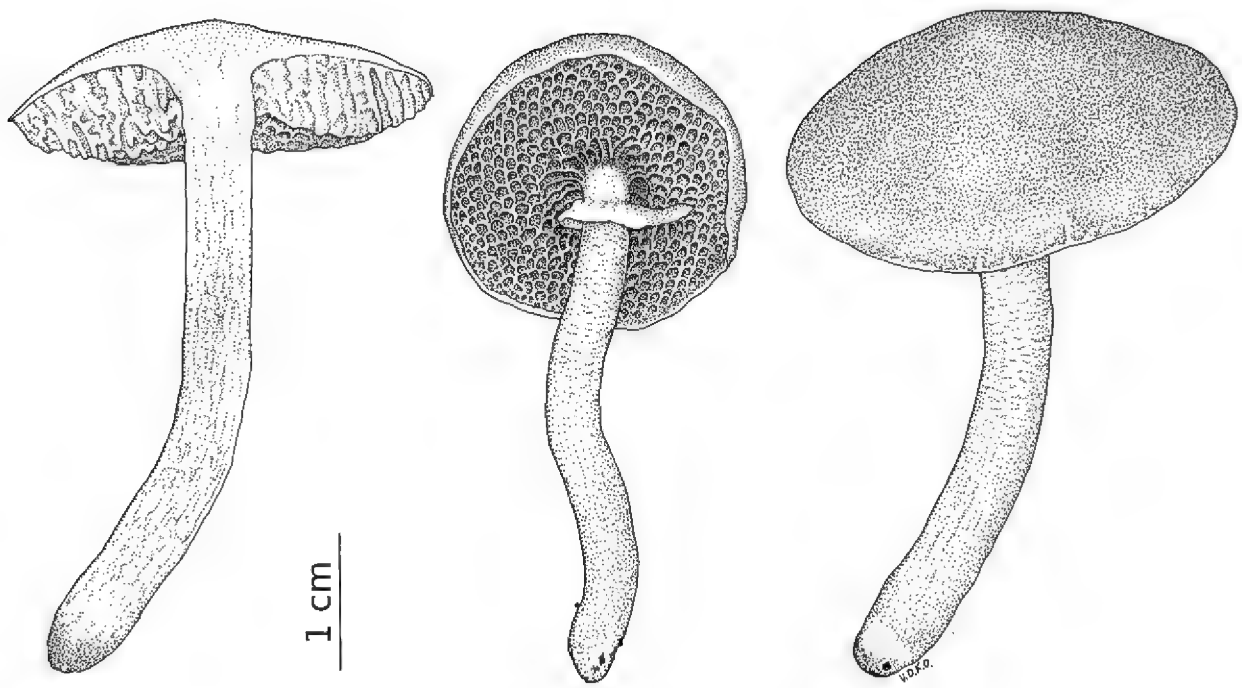

Fig. 1. *Pulveroboletus bembae* (Degreef 643, holotype). Basidiomes.

Pleurocystidia (57.4–92.6 × 9.4–17.4 µm), fusiformia, hyalina. Cheilocystidia (50.6–75.1 × 12.2–16.1 µm) fusiformia, crebra, hyalina. Trama phylloporoidea, sine mediostrata. Pileipellis physalo-palisadodermiformis; elementa terminalia brunnea, inflata vel spheropedunculata (25–45 × 20–40 µm); subpellis ex hyphis brevibus anticlinalem formantibus (20–40 × 5–8 µm). Elementa terminalia squamularum stipitis pileique 15–30 × 10–15 µm. Fibulae desunt.

Holotypus: Africa, Gabon, Woleu-Ntem Province, Bitouga, 8.IV.2008, Degreef 643 (BR).

Etymology: from 'bemba', name given by the Baka pygmies to the tree *Gilbertiodendron dewevrei* that is associated with the species.

Pileus 30–35 mm in diameter, convex, sometimes subumbonate, becoming plano-convex; almost uniformly rust-brown to reddish brown [6–8E6], with a slightly paler margin when young; surface dry, dull, becoming slightly shiny with age, rimulose towards the margin in older specimens; margin with a slightly exceeding pileipellis, deflexed, partly beset with velar remnants; context at the centre of the pileus < 4–5 mm thick, becoming very thin towards the margin, cream-colored to pale yellow [4A3] with pale reddish brown to light brown [7D4–5] shades under the pileipellis and down the stipe. Tubes subventricose, moderately depressed around the stipe, adnate, rarely with a decurrent tooth, < 5 mm long, greyish yellow [4B3–4C3] to mustard yellow [3B6]. Pores angular to round, more elongated around the stipe, < 1(–2) mm in diameter; concolorous with the tubes or a shade greener. Stipe 37–55 × 4–5 mm, central, cylindrical, with a narrow base 2–4 mm, sometimes with yellow [4A3] basal mycelium; solid, becoming stuffed to subfistulose with age; surface dull, dry,

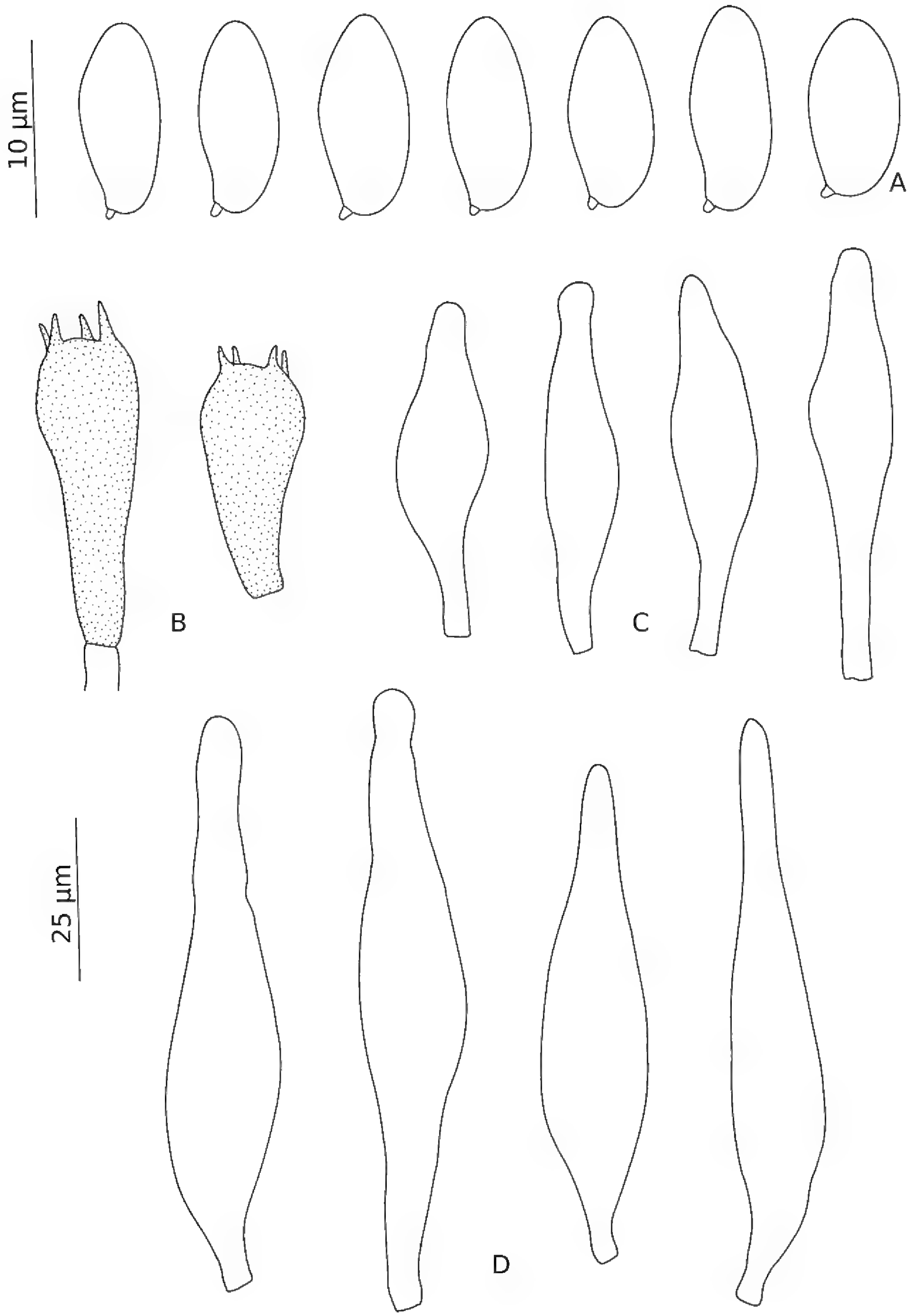

FIG. 2. *Pulveroboletus bembae* (Degreef 619). A. basidiospores; B. basidia; C. cheilocystidia; D. pleurocystidia. (A: scale bar = 10 µm; B–D: scale bar = 25 µm).

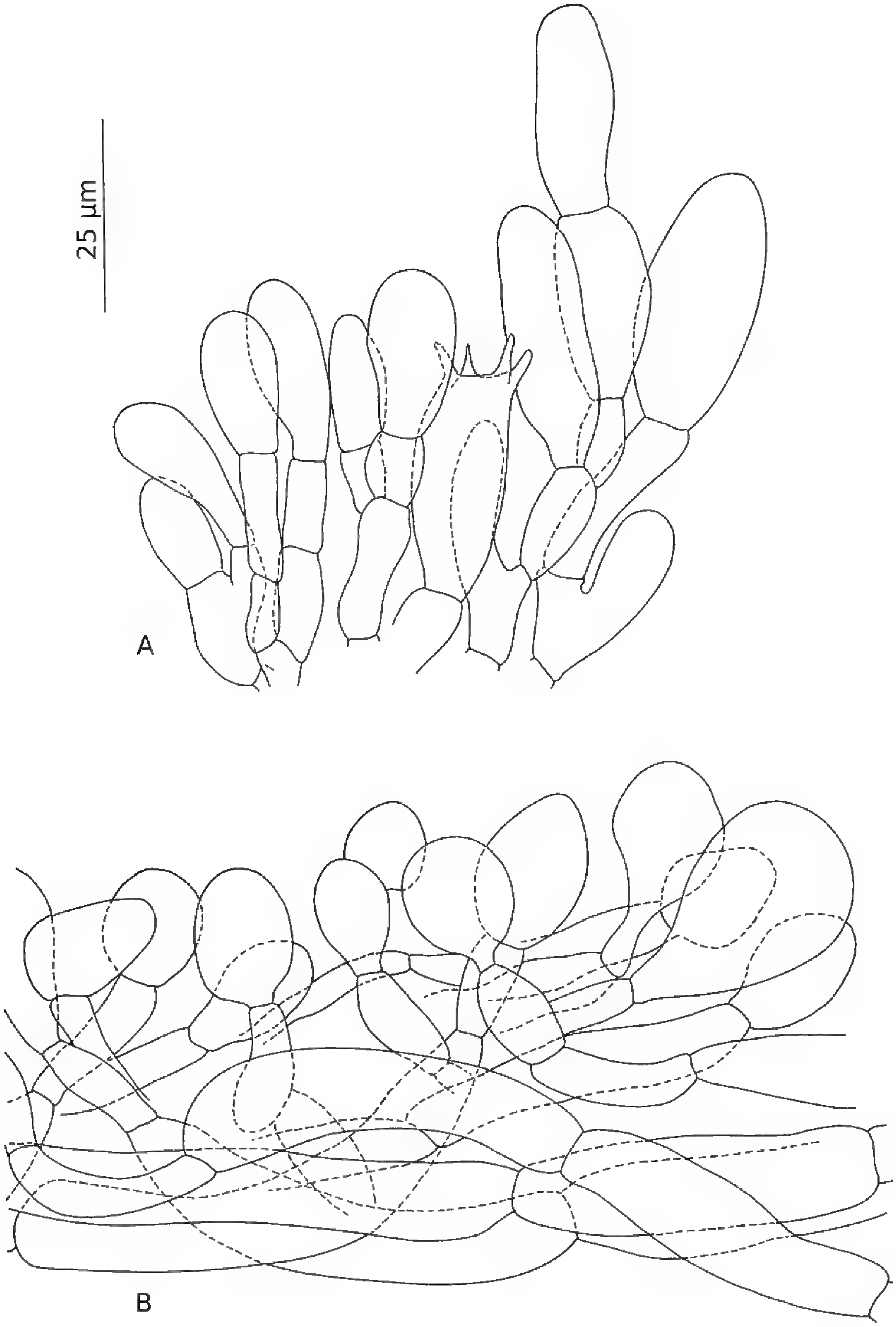

Fig. 3. *Pulveroboletus bembae* (Degreef 619). A. stipe squamule; B. pileipellis (profile views).

pale brown, entirely covered with minute brown to reddish brown [6–7D6–7] squamules; context cream-colored, streaked with pale reddish brown to light brown [7D4–5] from the upper third towards the base, the base light brown [7D4–5]. Annulus either on the stipe or the margin of the cap, very fine, wooly, whitish yellow, fragile and fugacious, usually lost in older specimens. Odour mildly fungoid to earthy. Taste mildly fungoid. Spore print not observed. Mycelium yellow.

Basidiospores (9.1–)9.3–*10.3*–11.3(–12.1) × (3.5–)3.9–*4.3*–4.7(–5.3) µm, l/w = (1.88–)2.13–*2.42*–2.71(–2.86) {N=48}, subfusiform, boletoid, with a pronounced suprahilar depression, weakly pigmented and rough (under SEM), inamyloid. Basidia (28.5–)26.9–*33.1*–39.3(–39.1) × (8.9–)9–*10.5*–12(–11.8) µm {N=24}, cylindrical to narrowly clavate, hyaline, with 4 sterigmata. Pleurocystidia (64.6–)57.4–*75*–92.6(–95) × (9.9–)9.4–*13.4*–17.4(–17.4) µm {N=21}, fusiform, moderately frequent, emergent, thin-walled, concolorous with the hymenium, hyaline, without crystals or encrustations. Cheilocystidia (52.2–)50.6–*62.9*–75.1(–73,9) × (11.7–)12.2–*14.1*–16.1(–15.6) µm {N=21}, fusiform, abundant to crowded, thin-walled, hyaline, without crystals or encrustations. Pileipellis a thin physalo-palisadoderm with short anticlinal hyphae of 20–40 × 5–8 µm supporting one or two inflated, brownish, globose to spheropedunculate terminal elements of 25–45 µm across, non-amyloid, thin-walled, without encrustations; mucilaginous layer not seen. Stipitipellis smooth parallel hyphae; squamules with a physalo-palisadodermic construction with short anticlinal elements supporting elongated inflated elements of 15–30 × 10–15 µm and some scattered basidia. Trama composed of hyaline, thin-walled hyphae, 10–15 µm wide, parallel, without a mediostratum. Clamp connections absent.

Ecology and distribution: guineo-congolian rainforest dominated by *Gilbertiodendron dewevrei* (*Caesalpinioideae*), growing in small groups.

Specimens examined– GABON. Ogooué-Ivindo Province, Ipassa-Makokou Research Station, N0°30'15" E12°46'49", 2.IV.2008, *Degreef* 601. Woleu-Ntem Province, Minkébé National Park, near Minvoul, N02°09'18" E12°08'07", 6.IV.2008, Degreef 619. Ibid., Bitouga, N02°07'08" E 12°07'42", 8.IV.2008, Degreef 643 (**Holotype**-BR).

Pulveroboletus luteocarneus Degreef & De Kesel, **sp. nov.** Figures 4–6

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Pileus 20–35 mm, convexus dein convexo-planus, rubro-brunneus, siccus, levis et tomentosus dein floccoso-squamosus et rugulosus, semper pallide ruber in fractu, margine praeter pallide ruber. Tubi 1 cm longi, adnati, subventricosi, griseo-lutei, immutabiles. Pori angulares, 0.5–0.7mm, rubro-brunnei, immutabiles, pulverulenti. Stipes 35–80 × 2–3 mm, procerus, cylindricus, impolitus, siccus, rubro-brunneus, subfurfuraceus, cum flocca rubro-brunnea tectus. Caro crassa, griseo-lutea, statim aurantiacescens. Basidiosporae

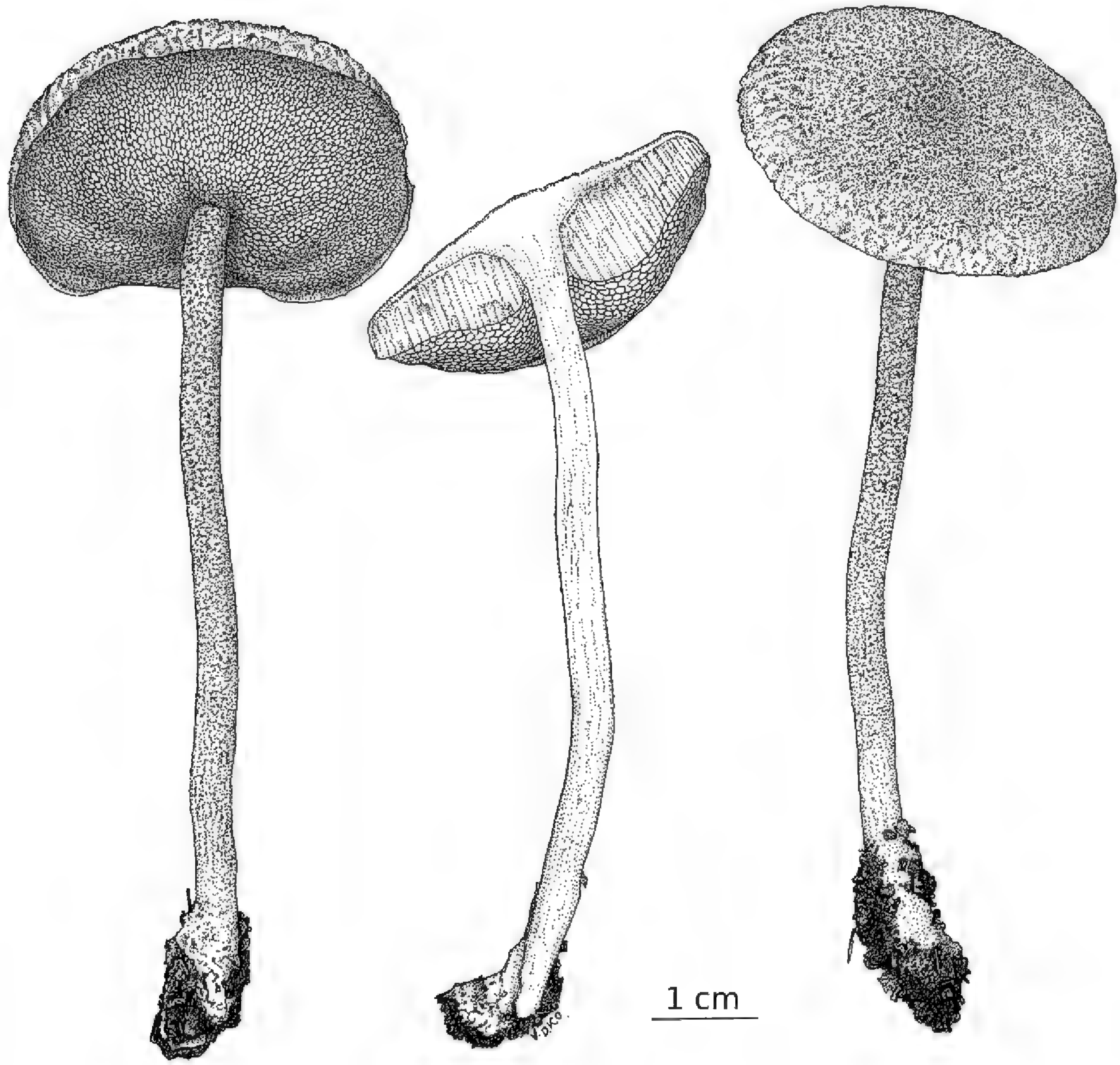

FIG. 4. *Pulveroboletus luteocarneus* (Degreef 632, holotype). Basidiomes.

(11.2–14.7 × 4.5–5.7 µm) subfusiformes vel boletiformes, scruposae, inamyloideae. Basidia (21.8–31.4 × 9.3–12.3 µm), subclavata, tetraspora. Pleurocystidia (36.7–73.4 × 8.5–14.4 µm), fusiformia, crebra, lutea, inamyloidea. Cheilocystidia (38.3–63.2 × 6.9–11.8 µm), fusiformia, lutea, inamyloidea. Trama tubi subboletoidea dein phylloporoidea, parallela, sine mediostrata. Pileipellis trichodermiformis; elementa terminalia rubro-brunnea, incrustata, cylindracea (30–80 × 15–20 µm). Squamulae stipitis rubro-brunneae, hymeniformes; elementa terminalia rubro-brunnea, levia, angusto-clavata, 50–85 × 12–20 µm. Fibulae desunt.

HOLOTYPUS: AFRICA, GABON, WOLEU-NTEM PROVINCE, MINKÉBÉ NATIONAL PARK, Doumassi, 7.IV.2008, Degreef 632 (BR).

ETYMOLOGY: refers to the context turning yellow orange after bruising.

PILEUS 20–35 mm in diameter, convex, becoming plano-convex; surface dry, dull, tomentose at first, coarsely tomentose and rugulose with age, moderately floccose-scaly near the margin, entirely brownish red at first [8F8, 8–9C5], later

pinkish or reddish white [7A2] in the ruptures and scars of the suprapellis; margin even to rugose, with slightly exceeding pileipellis, deflexed, without velar remnants except for a reddish pulverulence along the margin (magnifying glass); context at the centre of the pileus < 3–4 mm thick, fleshy, gradually becoming thin towards the margin, greyish red [9B4] at first, later reddish orange [7A6] with darker shades under the pileipellis and above the tubes. Tubes ventricose, adnate, without decurrent tooth, < 1 cm long, brownish orange [7C3] when young, soon becoming yellowish grey [4B2]. Pores mostly angular, regular, less than 0.5–0.7 mm in diameter, not staining when bruised, reddish brown to almost concolorous with the cap [9D5–9F8], with reddish-orange [7A–B7] encrusted velar remnants, persistent in older specimens as a red powdery pulverulence (sometimes scanty along margin of the cap). Stipe 35–80 × 2–3 mm, central, slender, cylindrical, terete, with normal to subbulbous base, without annulus, at first near the apex with reddish-orange [7A–B7] encrusted velar remnants, later locally pulverulent; surface dull, dry, entirely floccose-scaly, upper part brownish red [9C6] to reddish brown [9E5], pale greyish yellow [4A2–4B2] towards the base and in between the ruptures; context fibrous, stuffed, becoming hollow with age, beige [4A2], immediately becoming orange [5A5] when exposed. Odour and Taste weak, not distinctive. Spore print greyish yellow [4B4–4C4]. Mycelium yellow.

Basidiospores (11.3–)11.2–*13*–14.7(–15.6) × (4.4–)4.5–*5.1*–5.7(–5.7) µm, l/w = (2.09–)2.24–*2.54*–2.84(–2.95) {N=65}, subfusoid, boletoid, with a distinct suprahilar depression in profile, weakly pigmented and rough (under SEM), inamyloid. Basidia (23.2–)21.8–*26.6*–31.4(–32.5) × (9.3–)9.3–*10.8*–12.3(–12) µm {N=13}, clavate, hyaline, with 4 sterigmata. Pleurocystidia (38.8–)36.7–*55*–73.4(–81.4) × (7.8–)8.5–*11.5*–14.4(–15.3) µm {N=42}, abundant, narrowly fusiform to fusiform, sometimes clavate, emergent, thin-walled, with yellowish intracellular pigment (persistent in ammonia), without crystals or encrustations, inamyloid. Cheilocystidia (39.2–)38.3–*50.8*–63.2(–62.5) × (6.5–)6.9–*9.3*–11.8 (–11.1) µm {N=24}, similar to pleurocystidia, narrowly fusiform to fusiform. Pileipellis a trichoderm without mucilaginous layer, soon collapsed, forming a thin layer of matted parallel hyphae; terminal elements 30–80 × 15–20 µm, sparsely but distinctly encrusted, non-amyloid and thin-walled. Stipitipellis smooth parallel hyphae (stipe trama) supporting a caulohymenium, soon rupturing into floccose granules composed of densely tufted, elongate to club-shaped elements 50–85 × 12–20 µm, the latter thin walled, smooth, not encrusted, with distinct intracellular pigment; basidia not seen. Veil (partial) composed of non-persistent hyphae, heavily encrusted with reddish-orange crystals; the latter slowly dissolving in water and alkali (persistent in exsiccata, on pores and cap margin). Trama composed of hyaline, thin-walled hyphae, 8–12 µm wide, sub-boletoid at first, soon becoming parallel, with slightly

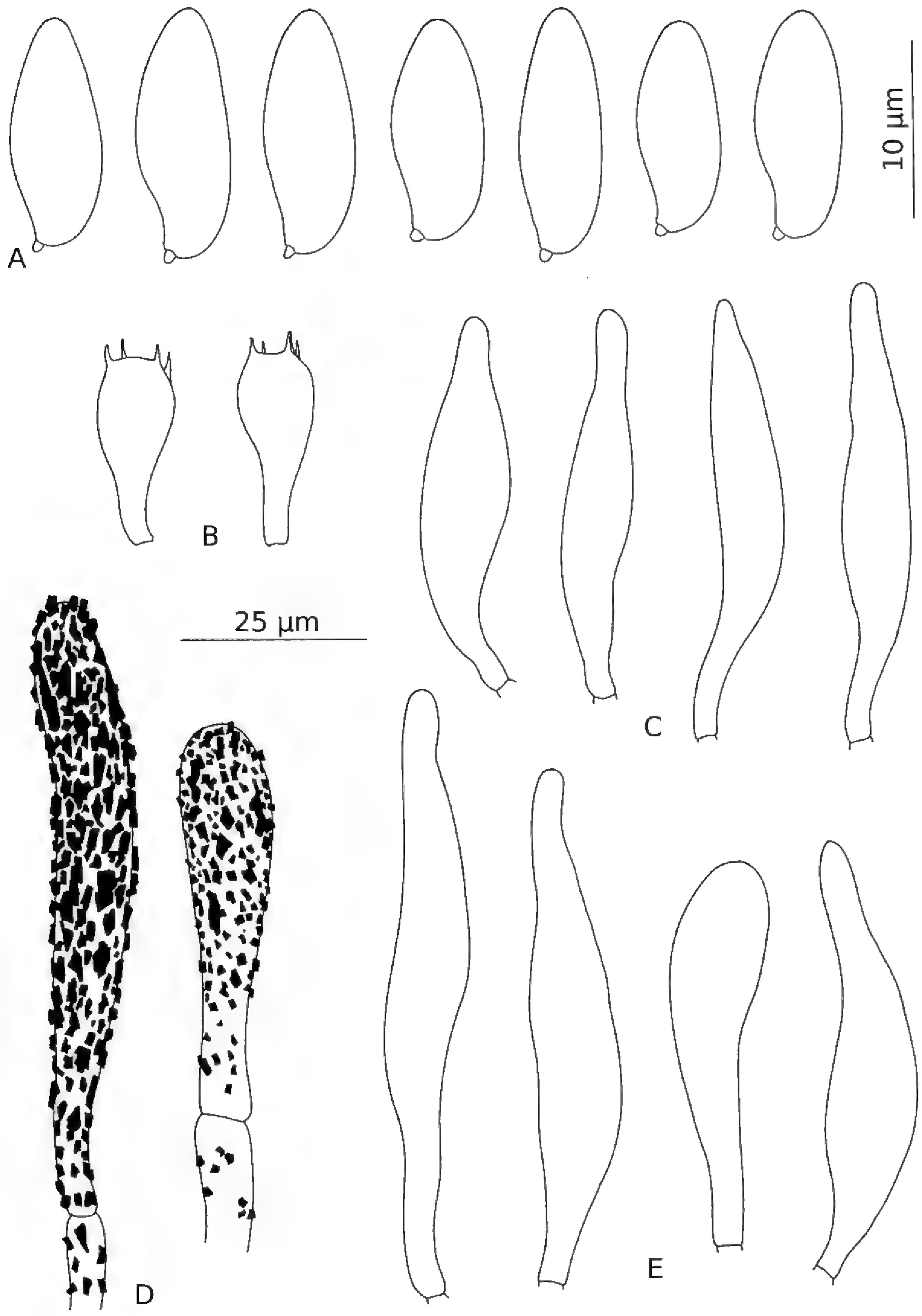

Fig. 5. *Pulveroboletus luteocarneus* (Degreef 632, holotype).
A. basidiospores; B. basidia; C. cheilocystidia;
D. incrusted velar remnants on the pores; E. pleurocystidia.
(A: scale bar = 10 µm; B–E: scale bar = 25 µm).

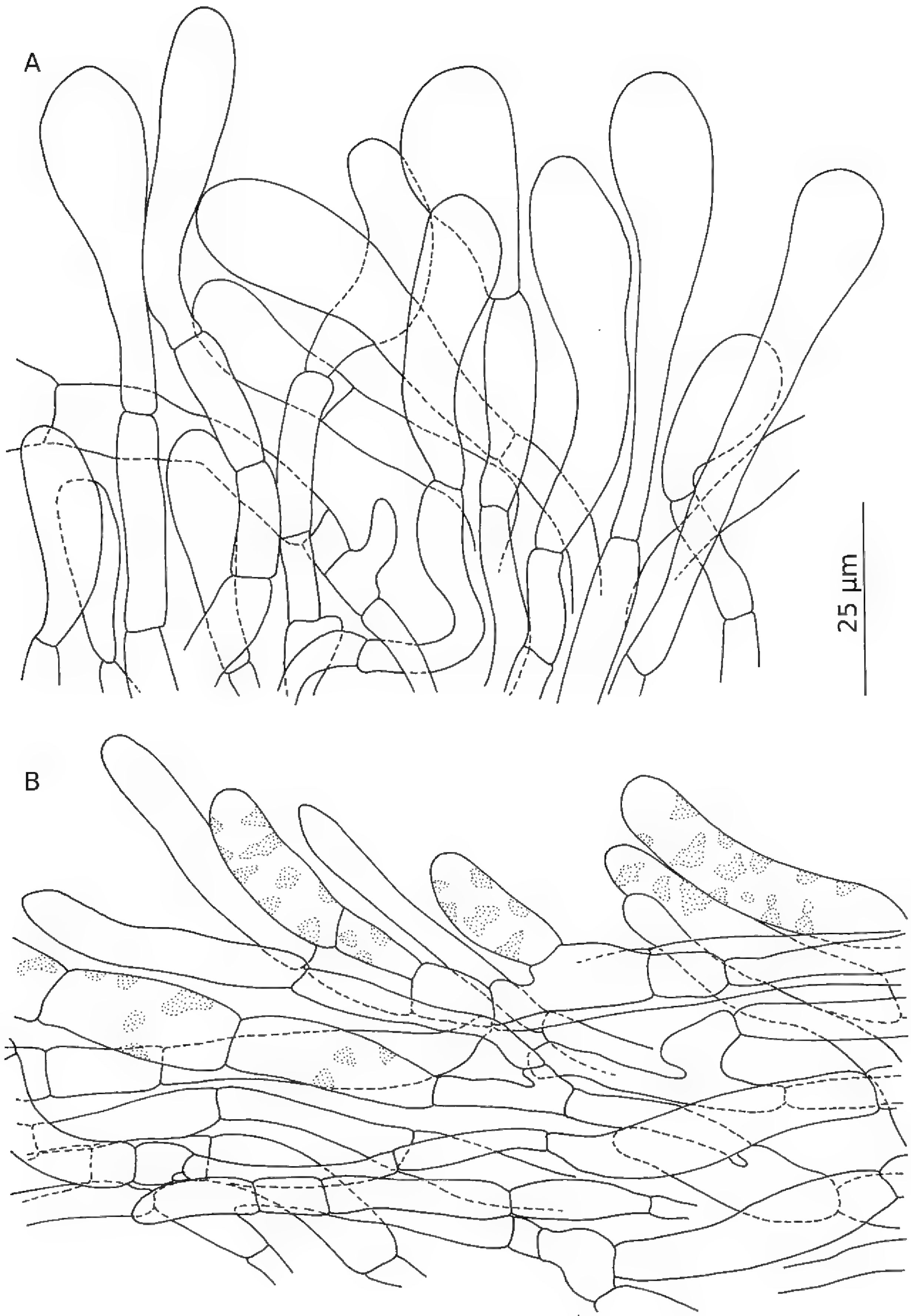

Fig. 6. *Pulveroboletus luteocarneus* (Degreef 632, holotype).
A. fibrils on upper stipe; B. pileipellis (profile views).

narrower hyphae 5–10 µm in the centre, without differentiated mediostratum. Clamp connections absent.

Ecology and distribution: guineo-congolian rain forest, growing solitary under *Uapaca guineensis* (*Euphorbiaceae*) or *Gilbertiodendron dewevrei* (*Caesalpinioideae*).

Specimens examined– GABON. Ogooué-Ivindo Province, Ipassa-Makokou Research Station, N0°30'04" E12°48'24", 24.III.2005, Degreef 315. Ibid., Kongou waterfalls, N0°17'24" E12°34'18", 9.IV.2006, Degreef 395. Woleu-Ntem Province, Minkébé National Park, Doumassi, N2°05'05" E12°10'10", 7.IV.2008, Degreef 632 (Holotype-BR) & 634.

Discussion

Whatever the circumscription of *Pulveroboletus* considered, i.e. restricted (sensu Murrill 1909) or enlarged (sensu Singer 1986), obviously both species described are presently best accommodated in the genus. In the classification scheme proposed by Watling (2008), both species key out under *Pulveroboletus*. Despite the overall appearance of the basidiomes that remind *Xerocomus* Quél., the presence of a detersile and powdery veil excludes this possibility. Considering the combined features, i.e. their ectomycorrhizal nature, the olivaceous component in the spore print and the phylloporoid tube trama (initially sub-boletoid), there is little doubt that *Pulveroboletus bembae* and *P. luteocarneus* belong in sect. *Pulveroboletus* sensu Singer. Compared to *P. ravenelii*, both new taxa lack the vivid yellow colour, the bluing context, and the prominently developed veil.

Pulveroboletus luteocarneus resembles *P. carminiporus* Heinem. It is easily separated from *P. carminiporus* by its changing orange context (non bluing), the presence of reddish-orange encrusted velar hyphae (upper part of the stipe and pores), and the ornamented spore surface (smooth in *P. carminiporus*). The taxonomic placement of *P. carminiporus* is still controversial. Singer (1986) placed the species under *Boletus*, in Section 1. *Subpruinosi* Fr. emend. Singer. There is very little against this, as the holotype (*Goossens-Fontana* 718, BR) fits the section's description and shows no clear evidence of a pulverulent veil. It could belong to *Xerocomus*.

Pulveroboletus bembae is morphologically close to *P. annulatus* Heinem. and *P. croceus* Heinem. There is some debate around the identity of the latter two species. Heinemann (1951) suspected their synonymy and Corner (1972), conversely, suggested a difference in carpogenesis (gymnocarpic in *P. croceus*). *Pulveroboletus bembae* clearly differs from both *P. annulatus* and *P. croceus* by its much larger hymenial cystidia (< 95 µm for pleurocystidia compared to maximum 75 µm in *P. annulatus* and *P. croceus*), cream-colored context with pale reddish brown to light brown shades under the pileipellis (evenly white

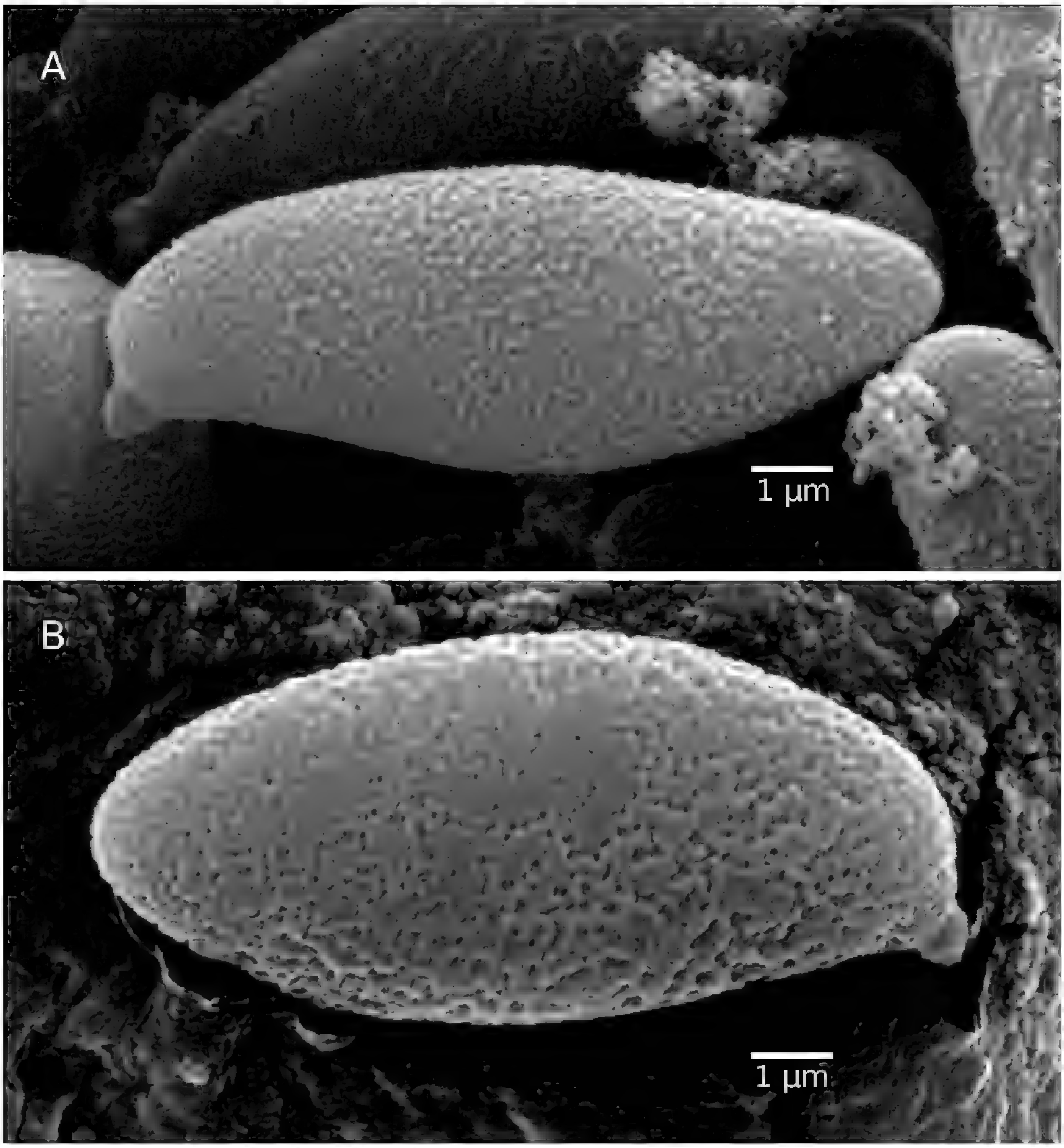

Fig. 7. SEM photographs of basidiospores.
A. *Pulveroboletus bembae* (Degreef 619); B. *Pulveroboletus luteocarneus* (Degreef 632, holotype).

in *P. annulatus* and *P. croceus*) and yellow mycelium (white in *P. annulatus* and *P. croceus*). Moreover, *P. bembae* has a different ecology growing in groups associated with *Gilbertiodendron dewevrei* in the rain forest, whereas *P. annulatus* and *P. croceus* occur solitary in the dry forest. It is beyond doubt that more young specimens are needed to sort out the presumed synonymy of *P. annulatus* and *P. croceus*.

Based on SEM, Pegler & Young (1981) have only reported smooth spored taxa in *Pulveroboletus*. This is also the case for most African types of the genus kept at BR (unpublished data). Nevertheless *P. annulatus* and *P. croceus* were

erroneously described as smooth-spored taxa (Heinemann 1951) because SEM was not available at that time. Our EM-scanning pictures of their type specimens (respectively *Goossens-Fontana* 976, BR and *Goossens-Fontana* 740, BR) revealed that both have a rough surface, very similar to the ones from *P. bembae* and *P. luteocarneus*. Adopting these four rough-spored taxa in *Pulveroboletus* can be considered as an extension to the circumscription of the genus. Further research is needed to decide whether these four, relatively slender and fragile species, belong in a well-defined group, i.e. a separate section of *Pulveroboletus*, characterized by rough spores.

Under the scanning electron microscope the spore surface of *P. bembae* and *P. luteocarneus* (Fig. 7) is comparable to that of *Austroboletus niveus* from New Zealand (Pegler & Young 1981: 135, fig. 139). The affiliation of both new taxa to *Austroboletus* is however unlikely because of the sharp difference in spore colour, i.e. vinaceous, purplish brown or pink in *Austroboletus*.

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Lichenostigma anatolicum sp. nov. (*Ascomycota, Lichenotheliaceae*) on a brown *Acarospora* from central Turkey

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Abstract — *Lichenostigma anatolicum* is described as new from the squamules of a brown, pruinose *Acarospora* sp. on gypsaceous rocks in central Turkey. It is compared here with three other species of *Lichenostigma* also known to occur on *Acarospora* spp. and *L. radicans* described on vagrant *Aspicilia* species.

Key words — biodiversity, lichenicolous fungi, lichens

Introduction

The lichenicolous genus *Lichenostigma* Hafellner was described by Hafellner (1983). It has a world-wide distribution and comprises 20 species (www.mycobank.org; accessed at 14 November 2008). Representatives of this genus are generally strongly host-specific, with the only exception being the type species, *Lichenostigma maureri* Hafellner, which is known from various fruticose lichens (e.g. Hafellner 1983, Halıcı 2008, Ihlen & Wedin 2008, Kocourková 2000). Halıcı (2008) previously reported five *Lichenostigma* species from Turkey, including the recently described *L. triseptatum* Halici & D.Hawksw. found on *Aspicilia* spp. (Halıcı & Hawksworth 2007).

During our studies of the biodiversity of lichenicolous fungi in Turkey, we collected a brown, pruinose *Acarospora* sp. on gypsaceous rocks from Central Turkey infected by a *Lichenostigma* species. The specimen was compared with three other *Lichenostigma* species also found growing on *Acarospora* spp. (Calatayud et al. 2002, Vondrák & Šoun 2007). We concluded that it is new to science and describe it here.

Material and methods

The type material of the new species is deposited in the herbarium of Erciyes University, Science & Art Faculty, Biology Department, Kayseri. Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics and a drawing tube. Photomicrographs were prepared on a Nikon Eclipse 80i. Sections were prepared by hand and examined in I (Lugol's iodine, with [KI] and without [I] pre-treatment with 10% KOH), 10% KOH alone, and water. Ascospore measurements were made in water; Ascospore measurements are given as: ('min.' –)'X –sd'–'*X*'– 'X + sd' (–'max.'), where 'min.' and 'max.' are the extreme values, 'X' the arithmetic mean, and 'sd' the corresponding standard deviation. The length/breadth ratio of ascospore is indicated as l/b and given in the same way.

The species

Lichenostigma anatolicum Halici & Kocakaya, **sp. nov.** FIGURE 1, 2

MycoBank MB 512854

Differt ab alior species in generis Lichenostigmiis in filamentis superficialis desunt ad parce evolutis, Habitat supra thalium Acarospora *sp.*

Typus: Turkey, Sivas, Gürün District, Gökpınar, 38°39.071'N, 37°18.309'E, alt. 1620 m, on thallus of a brown *Acarospora* sp. on gypsaceous rocks, 05 August 2008, leg. M. Kocakaya (MGH 0.5471 – **holotype**).

Etymology: The epithet "*anatolicum*" refers to the geographical region Anatolia in Turkey.

Description: Lichenicolous, on the thallus of a brown *Acarospora* sp. Mycelium absent or poorly developed on the surface of the host lichen. Short root-like, pale brown hyphae, arising from the lower part of the ascomata and penetrating downwards into the host thallus, slightly branched with a single row of cells, up to 30 μm long, cells ± elongated to subglobose, 6–10 × 5–7 μm. Ascomata black, shiny, scattered, semi-immersed to superficial, cushion-like, rounded, not constricted below, 35–50 μm tall, 70–110 μm wide; in section, upper part ± flat; lower part usually penetrating into the host thallus and connected to brown vegetative hyphae. Internal structure stromatic, paraplectenchymatous, cells ± spherical, mostly 5–6(–7) μm diam.; external cells with dark brown walls, with a granular pigment, internal cells paler. Interascal filaments lacking, centrum I+, KI+ bluish. Asci fissitunicate, subglobose to broadly obovate, 8-spored, KI–, I–, 20–22 × 16–19(–21) μm. Ascospores irregularly arranged in the asci, broadly obovate, brown, constantly 1-septate, non-halonate, slightly constricted at the septum, in the maturity with a finely verruculose surface, (9.0–)9.2–*10.5*–11.8(–13) × (5.0–)5.5–*6.3*–7.0(–7.5) μm (*n* = 32), l/b = (1.5–) 1.58–*1.68*–1.78(–1.85). Conidiomata not observed.

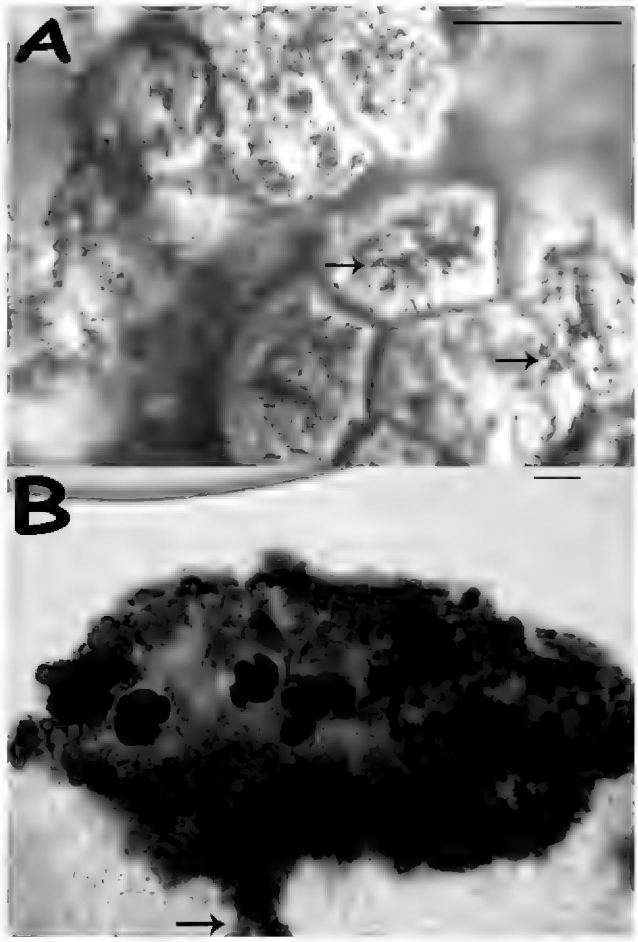

Fig. 1. ***Lichenostigma anatolicum*** (holotype). A. Infected thallus of *Acarospora* sp., B. Section of an ascomata, note the immersed brown vegetative hyphae arising from the lower part (arrow). Scales: A = 3 mm, B = 20 μm.

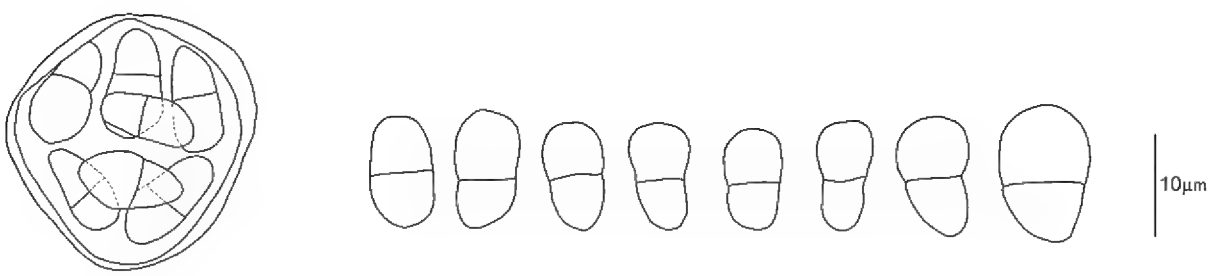

Fig. 2. ***Lichenostigma anatolicum*** (holotype). Ascus and ascospore outlines.

Ecology and distribution: The species is probably mildly pathogenic as it seems to suppress ascomata production in the host. No other damage to the host was observed. The new species is known from one locality from the central part of Turkey found growing on a brown pruinose *Acarospora* sp. on gypsaceous rocks. We inferred the host genus based on our familiarity with our lichen mycota and the presence of fertile *Acarospora* species on different rocks near the collection site. The host lichen might well represent *Acarospora cervina*, which is very common in the locality where this specimen was collected.

Observations: So far, three other species of *Lichenostigma* have been associated with *Acarospora. Lichenostigma* species growing on *Acarospora* spp. are compared in Table 1. *Lichenostigma anatolicum* is the only representative of subgenus *Lichenostigma* associated with *Acarospora*. Other species known to occur on *Acarospora* belong to subgenus *Lichenogramma*.

Table 1. Comparison of *Lichenostigma* species growing on *Acarospora* spp.

Character	*L. anatolicum*	*L. gracile*	*L. subradians*	*L. svandae*
Subgenus	*Lichenostigma*	*Lichenogramma*	*Lichenogramma*	*Lichenogramma*
Vegetative hyphae	Absent or poorly developed	Superficial, forming black ± orbicular groups	Superficial, forming black strands on the host surface	Superficial, irregular dark net-like patches
Position of ascomata	Semi-immersed to superficial	Superficial	Superficial	Superficial
Ascomata size (µm) (width × height)	70–110 × 35–50	45–120(–150) × 40–60	60–150 × 25–40	(50–)70–125(–160) × (20–)30–55(–70)
Ascomatal tissue	I_{Lugol} + bluish	I_{Lugol} –	I_{Lugol} –	I_{Lugol} –
Ascospores (µm)	9.2–*10.5*–11.8 × 5.5–*6.3*–7.0	9.0–*10.7*–12.0 × 5.0–*5.5*–6.0	9.0–*9.7*–10.0 × 5.0–*5.5*–6.0	11.7–*12.7*–13.7 × 6.5–*7.4*–8.3
Host	A brown *Acarospora* sp.	*Acarospora fuscata*	A yellow *Acarospora* sp.	*Acarospora cervina*
References	Present paper	Calatayud et al. (2002)	Calatayud et al. (2002)	Vondrák & Šoun (2007)

Lichenostigma svandae Vondrák & Šoun, a species recently described on *Acarospora cervina* from Ukraine and Czech Republic (Vondrák & Šoun 2007), has well developed superficial vegetative hyphae. *Lichenostigma svandae* also differs from *L. anatolicum* in having ascomatal tissue that is not stained by I+ blue and wider [(6–)6.5–*7.4*–8.3(–10) µm] ascospores (vs. (5–)5.5–*6.3*–7.0 (–7.5) µm).

The next two *Lichenostigma* species associated with *Acarospora* share similar ascospore sizes with *L. anatolicum*.

Lichenostigma gracile Calat. et al., which Calatayud et al. (2002) described on *Acarospora fuscata* on sandstone from Spain, is also known from Czech Republic (Peksa et al. 2007); *L. gracile* can be distinguished from *L. anatolicum* by its superficial vegetative hyphae that arise from a central point in a radial

pattern and ascomatal tissue that does not stain in I+ blue. Although the ascospores are similarly sized, *L. gracile* ascospores are occasionally 3-septate.

Lichenostigma subradians Hafellner et al., which was described on a yellow *Acarospora* from Arizona, USA, is distributed across dry areas such as Saudi Arabia, Canary Islands, and the Sonoran desert in western North America (Calatayud et al. 2002). Similar to *L. gracile, L. subradians* has also radially arranged, strongly branched superficial vegetative hyphae and ascomatal tissue that does not stain in I+blue.

In the lack of superficial hyphae, *Lichenostigma anatolicum* resembles *Lichenostigma radicans* Calat. & Barreno, a species described on vagrant *Aspicilia* species in Spain (Calatayud & Barreno 2003). In addition to living in different lichen hosts on different substrata, *L. anatolicum* differs from *L. radicans* by having I+ bluish ascomatal tissues, smaller ascomata [70–110 µm wide and 35–50 µm tall vs. 90–170 µm wide, 45–70 µm tall], usually superficial ascomata, and slightly shorter ascospores [(9–)10–*11.1*–13(–14) µm vs. (9.0–)9.2–*10.5*–11.8(–13) µm]. Table 2 compares *L. anatolicum* with other representatives of subgenus *Lichenostigma* (the most common species on saxicolous lichens, cf. Calatayud et al. 2004, Pérez-Ortega & Calatayud 2009, Thor 1985).

Table 2. Comparison of *Lichenostigma anatolica* with some other members of subgenus *Lichenostigma*.

Character	*L. anatolicum*	*L. dimelaenae*	*L. epirupestre*	*L. lecanorae*	*L. rugosum*
Vegetative hyphae	Absent or poorly developed	Absent	Absent	Absent	Absent
Position of ascomata	Semi-immersed to superficial	Superficial	Superficial	Superficial	Superficial
Ascomata size (µm) (width × height)	70–110 × 35–50	70–140 × 40–80	80–270 × 40–95 (–110)	120–300 × 120–200	50–200 × 30–50
Ascomatal tissue	I_{Lugol}+ bluish	I_{Lugol}+ pale red	I_{Lugol}+ blue	I_{Lugol}–	I_{Lugol}–
Ascospores (µm)	9.2–*10.5*–11.8 × 5.5–*6.3*–7.0	11–15 × 6.5–11	11–*12.6*–14 × 6.6–*7.1*–8	10–15 × 6–9	10–13 × 5–7
Host	A brown *Acarospora* sp.	*Dimelaena oreina*	*Pertusaria pertusa* var. *rupestris*	*Lecanora farinacea*	*Diploschistes* species
References	Present paper	Calatayud et al. (2004)	Pérez-Ortega & Calatayud (2009)	Calatayud et al. (2004)	Thor (1985), Calatayud et al. (2004)

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Rhytisma huangshanense sp. nov. described from morphological and molecular data

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Abstract — A fungus collected from the Huangshan Mountains in Anhui Province, China is described as a new species, *Rhytisma huangshanense.* The new species, occurring on leaves of *Rhododendron simsii*, is similar to foliicolous species of *Coccomyces* but differs in having thicker epiphyllous ascomata that open by a more or less longitudinal split. Analyses based on partial small subunit or large subunit nuclear ribosomal DNA sequences confirm placement of *R. huangshanense* in the genus.

Key words — LSU rDNA, *Rhytismatales*, SSU rDNA, taxonomy

Introduction

Species of *Rhytisma* Fr. are parasites causing tar-spot symptoms on leaves of broadleaf trees, and most of them are highly host-specific (Hou & Piepenbring 2005). In most species, stromata develop on living leaves to produce spermatial morphs, with the meiotic stage appearing the following season on fallen and overwintered leaves. Most records of *Rhytisma* species are based on observations of stromata on living leaves (Cannon & Minter 1986, Hou 2004, Hou & Piepenbring 2005).

In China, 11 species of *Rhytisma* have been reported (Hou & Piepenbring 2005). Among them, six have been described in detail with ascomatal morphology and the remaining species will be restudied when mature ascomata are available in future. In the present paper we describe a new species of *Rhytisma* on *Rhododendron simsii* Planch. from the Huangshan Mountains in Anhui Province, China.

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Table 1. SSU rDNA sequences of the species used in the study and their GenBank accession numbers

Species	Voucher specimen	GenBank accession No.
Blumeria graminis f. sp. bromi		AB033476
Bulgaria inquinans		DQ471008
Byssoascus striatosporus		AB015776
Chloroscypha chloromela		AF203461
Coccomyces dentatus		AY544701
Coccomyces strobi		DQ471027
Colpoma quercinum		AF203452
Cudonia circinans		AF107343
Cyclaneusma minus		AF203458
Elytroderma deformans		AF203455
Hymenoscyphus fructigenus		HFU67430
Lirula macrospora		AF203453
Lophodermium pinastri		AF106014
Meloderma desmazieresii		AF203454
Microglossum viride		MVU46031
Oidiodendron tenuissimum		AB015787
Phacidium coniferarum		AF203467
Rhytisma acerinum		AF356695
Rhytisma huangshanense	Hou et al. 564	FJ495193
Rhytisma salicinum		RSU53370
Spathularia flavida		AF107344
Spathularia velutipes		AF281072
Tryblidiopsis pinastri		DQ471035

Table 2. LSU rDNA sequences of the species used in the study and their GenBank accession numbers

Species	Voucher specimen	GenBank accession No.
Coccomyces dentatus		AY544657
Coccomyces strobi		DQ470975
Colpoma quercinum		EU833991
Cudonia circinans		AY533013
Cudonia lutea		AF433140
Cudonia sichuanensis		AF433137
Cyclaneusma minus		FJ176868
Lophodermium pinastri		AY004334
Meria laricis		DQ470954
Potebniamyces pyri		DQ470949
Rhytisma acerinum		AF356696
Rhytisma acerinum		EU833992
Rhytisma acerinum	Hou et al. 203	FJ495190
Rhytisma salicinum	Hou et al. 70	FJ495191
Rhytisma huangshanense	Hou et al. 564	FJ495192
Spathularia flavida		AY541496
Spathularia velutipes		AF279411
Tryblidiopsis pinastri		DQ470983

Materials and methods

Morphological study

Sections of ascomata of different thicknesses were made by hand using a razor blade. Microscopic preparations were made in water, Melzer's reagent, 5% (w/v) KOH, or 0.1% (w/v) cotton blue in lactic acid. For observation of ascomatal outlines in vertical section, sections were mounted in lactic acid or cotton blue with pretreatment in water. Gelatinous sheaths surrounding the ascospores and paraphyses were observed in water or cotton blue. Measurements were made from 20 ascospores and asci for each specimen using material mounted in 5% KOH.

Molecular methods

Total genomic DNA was extracted from herbarium material using the PeqLab E.Z.N.A.® Fungal DNA kit following the manufacturer's protocol after the samples were crushed by shaking for 3 min at 30 Hz (Mixer Mill MM 301, Retsch, Haan, Germany) in a 1.5 ml tube together with one 3 mm in diam. tungsten carbide ball. The SSU/LSU rDNA regions were amplified using the primers pairs NS1/NS4 and LR0R/R5 (White et al. 1990, Vilgalys and Hester 1990). PCR was performed in 25 µl reactions including, DNA template 1.0 µl, primer1/2 1.0 µl, 2 × MasterMix 12.5 µl, and H_2O, under the following parameters: 94 °C for 40 seconds, 50 °C for SSU/45 °C for LSU for 55 seconds, 72 °C for 1 minute, for a total of 30 cycles followed by a final extension step at 72 °C for 7 minutes. The PCR products were sent to Invitrogen Biotechnology Co. Ltd. (Beijing, China) for purifying, sequencing and editing. The other SSU/LSU rDNA sequence data included in this study were downloaded from GenBank (Tables 1–2).

Phylogenetic analyses

DNA sequences were aligned with Clustal X (Thompson et al. 1997). Further manual alignment was done in Se-Al v.2.03a (Rambaut 2000). The insertion sequences and sections of the sequences longer than the sequence of the new species were excluded from the analyses. Two data sets of the SSU/LSU rDNA sequence data were prepared and were analyzed separately using maximum parsimony methods performed in PAUP* 4.0b10 (Swofford 1998). Maximum parsimony analyses were conducted using heuristic searches with 1000 replicates of random-addition sequence, tree bisection reconnection (TBR) branch swapping and no maxtree limit. All characters were equally weighted and unordered. Gaps were treated as missing data to minimize homology assumptions. A bootstrap analysis was performed with 1000 replicates, each with 10 random taxon addition sequences. MAXTREES was set to 1000, and TBR branch swapping was employed.

Results

Morphological analyses indicate that the specimen collected from the Huangshan Mountains in Anhui Province, China represents a new species of *Rhytisma* (Figs. 1–8).

The length of the SSU alignment was 921bp, with 66 phylogentically informative positions. The maximum parsimony analyses of sequences resulted in one most parsimonious tree (Fig. 9) with a length (TL) of 239 steps, consistency index (CI) of 0.6975, retention index (RI) of 0.7012, homoplasy index (HI) of 0.3025, and rescaled consistency index (RC) of 0.6971. The length of the LSU alignment was 849 bp, with 122 phylogentically informative positions. The maximum parsimony analyses of sequences resulted in one most parsimonious tree (Fig. 10) with a length TL of 380 steps, CI of 0.6579, RI of 0.6524, HI of 0.4483, and rescaled RC of 0.4292.

The results showed that *Rhytisma huangshanense* formed a well supported sister clade to *R. salicinum* (Pers.) Fr. in analyses of sequences of SSU rDNA and a well supported monophyletic clade to *Rhytisma* species in analyses of sequences of LSU rDNA.

Taxonomy

Rhytisma huangshanense C.L. Hou & M.M. Wang, **sp. nov.** Figures 1–8

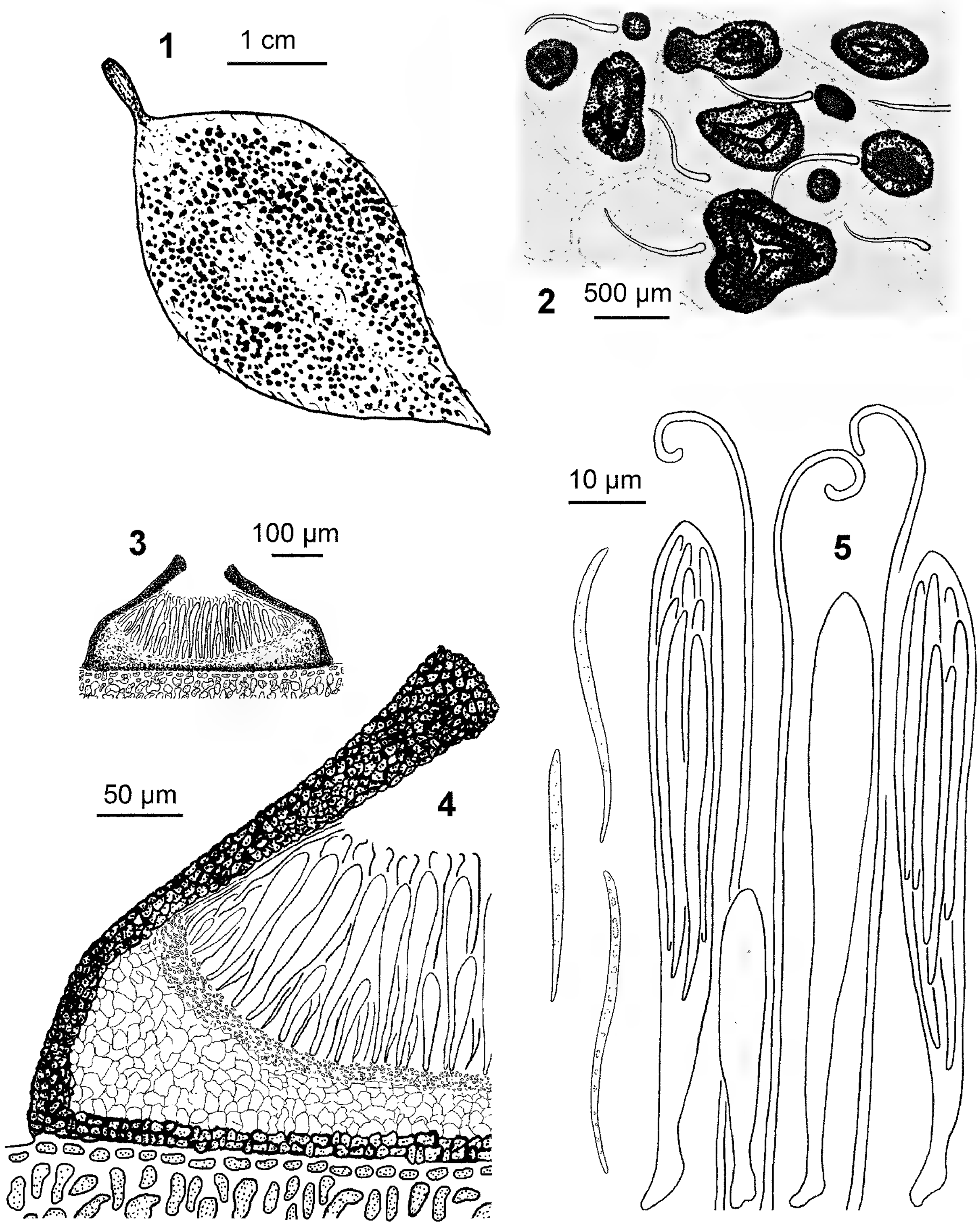
MycoBank 512114

Ascomata 250–1000 × 250–650 µm, epiphylla, subcuticularia, nigra, elliptica, orbicularia vel irregularia; paraphyses filiformes, circinatae; asci 70–110 × 7–10 µm, cylindrici vel clavati; ascosporae 35–60 × 2–2.5 µm, cylindricae, filiformes.

Etymology: *huangshanense*, referring to the Huangshan Mountains where the specimen was collected.

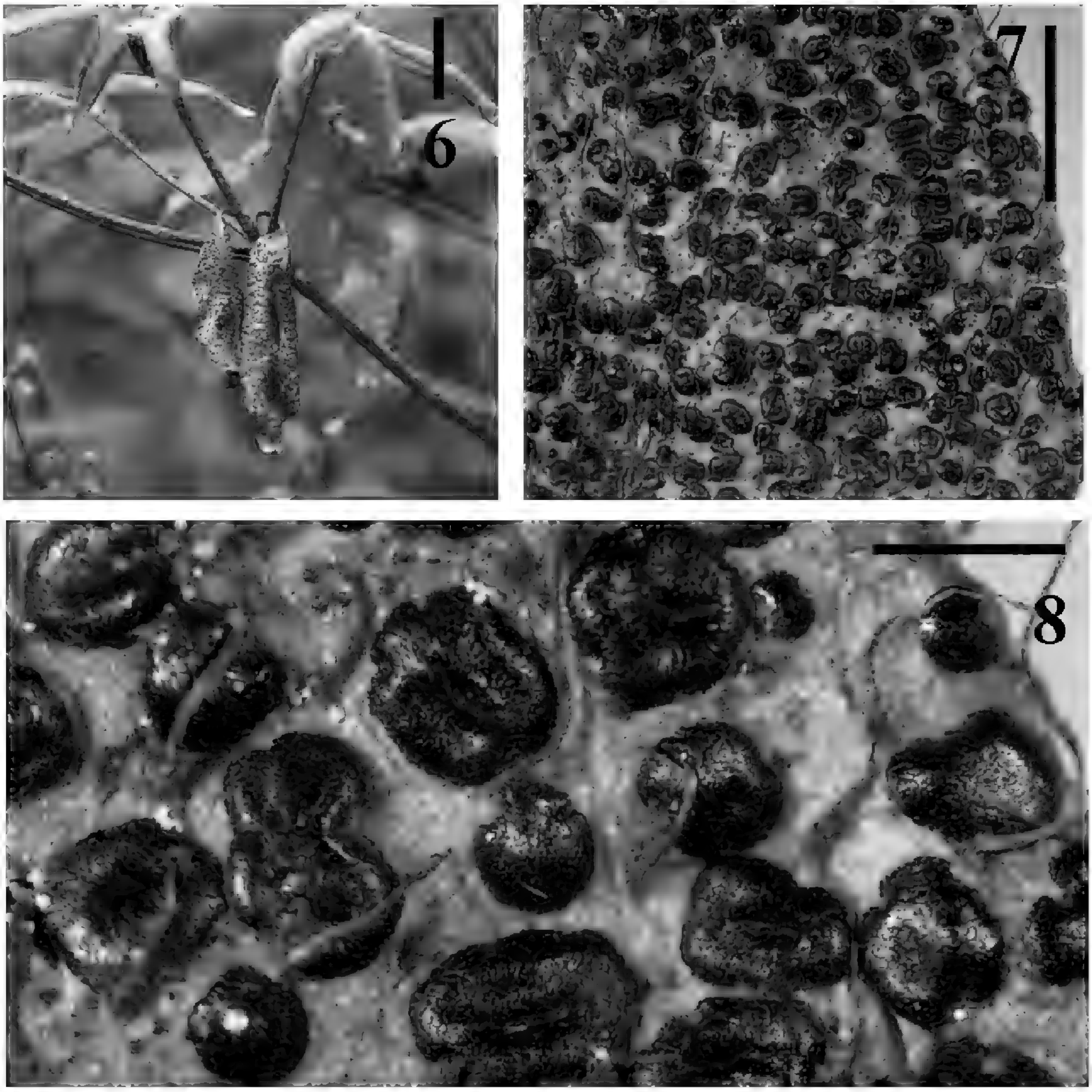
Holotype: on leaves of *Rhododendron simsii* (*Ericaceae*), CHINA. ANHUI, the Huangshan Mountains, Tianhai, alt. ca. 1700 m, 10 June 2006, C. L. Hou, M. M. Wang & L. Zhang 564 (AAUF).

Ascomata on dead leaves, epiphyllous, elliptical, orbicular or slightly irregular, black, shiny, single, occasionally coalescing, spreading over the whole surface of the leaf, 250–1000 × 250–650 µm, strongly raising the surface of the substrate, often with central papilla when immature, opening with a longitudinal split, or with slightly irregular splits when ascomata are coalesced. Lips cells absent. In median vertical section, ascomata subcuticular, covering stroma to 30–45 µm thick near the centre of the ascoma, sometimes slightly thinner towards the edges, extending to the basal stroma, consisting of an outer layer of host cuticle, and an inner layer of black, thick-walled angular cells. Basal stroma well-developed, 40–65 µm thick, composed of an outer layer of two rows of black, thick-walled, angular cells and an inner layer of 3–4 rows of hyaline, thin-walled angular cells. Subhymenium consisting of textura intricata, 10–15



Figs 1–5. *Rhytisma huangshanense* on leaves of *Rhododendron simsii*. 1. A Leaf bearing ascomata. 2. Ascomata observed under the dissecting microscope. 3. Ascoma in vertical section. 4. Structure of an ascoma in vertical section. 5. Paraphyses, a young ascus, an ascus after the liberation of the ascospores, two mature asci with ascospores, and discharged ascospores.

μm thick. Paraphyses 120–150 × 1.5–2 μm, filiform, unbranched, circinate at the apex. Asci ripening sequentially, 70–110 × 7–10 μm, ± cylindrical-clavate, short-stalked, slightly acute at the apex, 8-spored, thin-walled, without circumapical thickening, J-. Ascospores 35–60 × 2–2.5 μm, filiform, slightly sigmoid when released, slightly tapering toward the tips and more towards the bases, hyaline, aseptate, without gelatinous sheaths.



Figs 6–8. Photographs of *Rhytisma huangshanense*. 6. Two Leaves bearing ascomata attached to a twig of *Rhododendron simsii*. Scale bar = 1 cm. 7. Ascomata on a leaf. Scale bar = 5 mm. 8. Ascomata on a leaf. Scale bar = 1 mm.

Conidiomata and Zone lines not seen.

Distribution: Only from the type locality.

Habitat: Collected on dead leaves which are still attached to twigs.

Discussion

Ascomatal shapes of *Rhytisma huangshanense* are somewhat similar to some foliicolous species of *Coccomyces* De Not. and some species of *Rhytisma*. SSU rDNA sequence analyses showed that our new species was closely related to *R. salicinum* with 99% bootstrap support but distantly related to a sequence reported to be of the type species of *Rhytisma*, *R. acerinum* (Pers.) Fr.

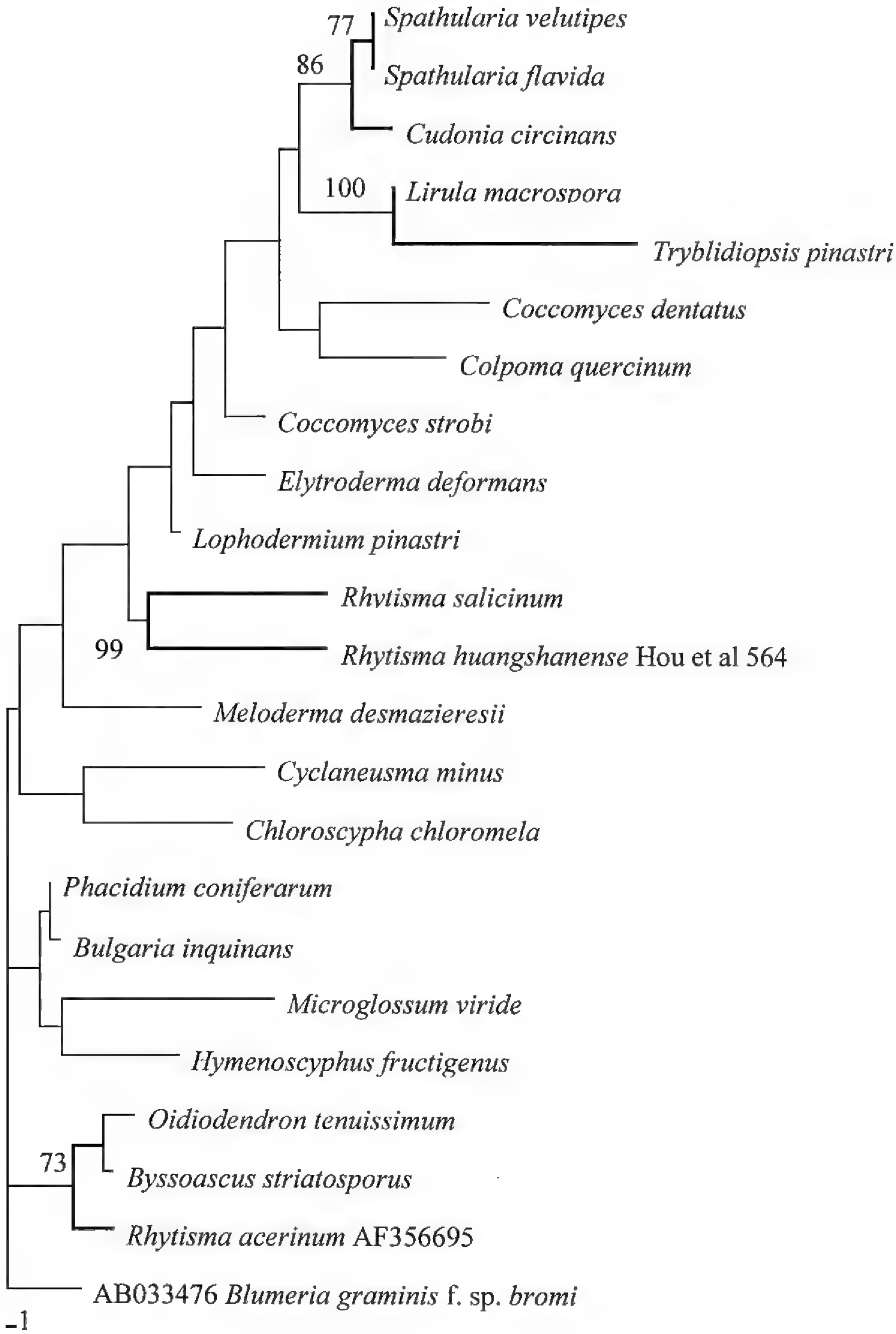


Fig. 9. Phylogenetic hypothesis derived from maximum parsimony analysis of partial nuclear small subunit ribosomal RNA gene sequences of *Rhytisma huangshanense* and other related species, using *Blumeria graminis f.* sp. *bromi* as an outgroup. Bootstrap values of more than 70 % from 1000 replications are shown on the respective branches (bold).

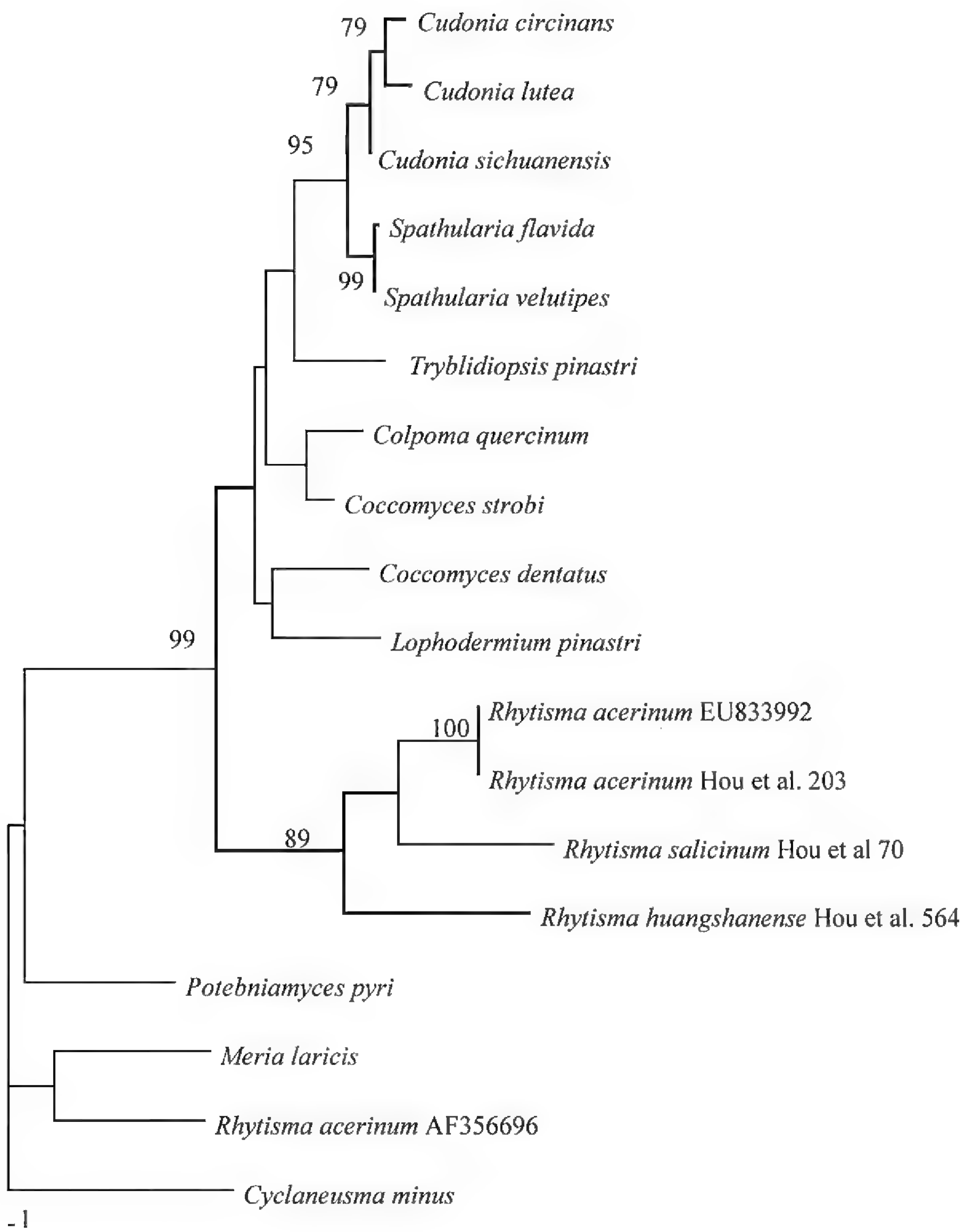


Fig. 10. Phylogenetic hypothesis derived from maximum parsimony analysis of partial nuclear large subunit ribosomal RNA gene sequences of *Rhytisma huangshanense* and other related species, using *Cyclaneusma minus* as an outgroup. Bootstrap values of more than 70 % from 1000 replications are shown on the respective branches (bold).

(GenBank AF356695), which formed a group with members of *Myxotrichaceae* (*Ascomycota* incertae sedis). Therefore a sequence of SSU rDNA from a trustworthy collection of *R. acerinum* should be obtained for comparison with AF356695. LSU rDNA sequence analysis showed that *R. huangshanense* formed

a monophyletic clade with *R. acerinum* and *R. salicinum* with 88% bootstrap support. *R. huangshanense* was distantly related to *Coccomyces* species and other rhytismatalean species. The LSU sequence of *R. acerinum* in GenBank (AF356696) also is likely from a misidentified source. The other LSU sequences from *R. acerinum*, EU833992 and Hou et al. 203, are congruent with the expected phylogeny. Sequences of EU833992 and Hou et al. 203 are identical while the sequence similarity for AF356696 and EU833992 is only 88%.

Species of *Rhytisma* are usually parasitic on living leaves, though one species, *Rhytisma yuexiense* C.-L. Hou & M. Piepenbr., however, has been observed only on fallen leaves (Hou & Piepenbring 2005). Ascomata of *Rhytisma* species open by a more or less longitudinal split. *Coccomyces* species mostly inhabit fallen leaves and their ascomata open by more or less radiate splits. Due to lack of molecular data, the type species of *Coccomyces*, *C. tumidus* (Fr.) De Not. was not included in the phylogenetic analyses. However, the type species *Rhytisma*, *R. acerinum* is distinct from *C. tumidus* in ecology and ascomal development.

Five species of *Rhytisma* on *Rhododendron* spp. are known worldwide (Farr et al. 1996, Hou & Piepenbring 2005). *R. huangshanense* with unilocular stromata is similar to *Rhytisma anhuiense* C.-L. Hou & M. Piepenbr., *R. rhododendri-oldhamii* Sawada (invalidly published), *R. rhododendri* Fr. and *R. shiraiana* Hemmi & Kurata (Hemmi & Kurata 1931, Hou & Piepenbring 2005, Saccardo 1889, Sawada 1943). *R. anhuiense* has hypophyllous ascomata opening by irregular splits and clavate asci with clavate to slightly cylindrical ascospores, and is distinct from *R. huangshanense*. Owing to the much larger, rugose stromata (4–6 × 3–4 mm), *R. rhododendri* is undoubtedly a different species from *R. huangshanense*, which has small stromata (250–1000 × 250–650 µm), spread throughout the leaves rather than big tar spots. *R. rhododendri-oldhamii* has much wider asci (73–140 × 13–16 µm) and ascospores (40–55× 3.5–5 µm) than those of *R. huangshanense*, with paraphyses straight rather than hooked or twisted at the tips. Paraphyses of *R. shiraiana* are similar to the present species. However, *R. shiraiana* has larger stromata (up to 3 mm diam.), much wider and longer asci (99–147 × 11–14 µm), and much wider ascospores (21–45 × 2.8–3.8 µm) than those of *R. huangshanense*.

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New combinations and new species in the lichen genera *Hemithecium* and *Pallidogramme*

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Abstract—Eight species in the lichen genera *Hemithecium* and *Pallidogramme*, including three new species *Hemithecium microspermum*, *Pallidogramme indica*, and *P. undulatolirellata* and five new combinations *Hemithecium epixanthum*, *H. multistriatum H. salacinilabiatum*, *H. stictilabiatum*, and *Pallidogramme commutabilis* have been recognized.

Keywords—*Graphidaceae*, taxonomy, ascomycetes, Maharashtra, India

Introduction

In her recent treatment of the lichen family *Graphidaceae*, Staiger (2002) reintroduced the genus *Hemithecium* Trevis. and reported nine species in this genus. Subsequently, 24 species have been added to *Hemithecium*, including 12 species from the Indian subcontinent (Archer 2006, Adawadkar & Makhija 2005, Makhija & Adawadkar 2005, Makhija et al. 2005, Nakanishi et al. 2003).

The occurrence of ten *Hemithecium* species has been confirmed in the lichen flora of Maharashtra state of India. Five species belonging to *Hemithecium* with hyaline, trans-septate ascospores have already been recorded in a recent publication (Makhija et al. 2005). In the present paper the remaining five species of this genus from Maharashtra are recorded including one species new to science and four new combinations.

In addition, three species in *Pallidogramme* Staiger et al., a genus that was recently introduced to accommodate the species in *Hemithecium* subgenus *Leucogramma* Staiger (Lücking et al. 2008), have also been recorded from Maharashtra and are described below.

Material and methods

Chemical constituents were identified by thin-layer chromatography using methods standardized for lichen products (Culberson & Kristinsson 1970,

Culberson 1972, White & James 1985) with the solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-ethyl ether-formic acid (130:80:20) and toluene-ethyl acetate-formic acid (139:83:8). All specimens examined are deposited in Ajrekar Mycological Herbarium (AMH).

Key to the species

1a. Ascospores brown .... (*Pallidogramme*) 2

1b. Ascospores hyaline .... (*Hemithecium*) 4

2a. Ascospores muriform (ascomata aggregated in patches, 5–7 mm long, branched; exciple non-striate, uncarbonised or slightly carbonised at the tips; ascospores 66–126×21–30 µm; no lichen substances present) .... ***P. commutabilis***

2b. Ascospores trans-septate 3

3a. Ascomata wavy, simple to sometimes branched, short, 0.5–6 mm long; disc whitish; exciple with 2–4 indistinct striae, slightly carbonised at the tips; asci 4–8-spored; ascospores brown, 9–13–trans-septate, 25–49×5–9 µm; norstictic, stictic and constictic acids present .... ***P. undulatolirellata***

3b. Ascomata branched, 1–13 mm long; disc epruinose, exciple brownish, non–striate; asci 2–8-spored; ascospores brown, 13–20–trans-septate, 46–81×7–11 µm; stictic acid and constictic (trace) acids present .... ***P. indica***

4a. Ascospores muriform, exceeding 100 µm in length 5

4b. Ascospores muriform, not exceeding 100 µm in length 7

5a. Lichen substances absent (ascomata distinctly emergent, simple, rarely branched, tri-radiate, 1–7 mm long and 0.2–0.5 mm wide; disc whitish; exciple pale woody brown to dull cream coloured, 4–5 striate; asci 1–2-spored; ascospores ellipsoid to fusiform 150–200×60–75 µm) .... ***H. multistriatum***

5b. Lichen substances present 6

6a. Ascomata emergent, 1–9 mm long; proper exciple uncarbonised, 4–5 striate; ascospores 130–200×35–60 µm; salazinic acid present .... ***H. salacinilabiatum***

6b. Ascomata emergent, 1–10 mm long; proper exciple, uncarbonised, striate; ascospores 112–209×30–66 µm; stictic acid present .... ***H. stictilabiatum***

7a. Ascomata 1–7.5 mm long and 0.1–0.2 mm wide, mostly simple to irregularly branched, flexuous; exciple convergent, non-striate or with 1–2 apical grooves; ascospores 17–21×8–14 µm; constictic, stictic, hyposalazinic and norstictic acids present .... ***H. microspermum***

7b. Ascomata 2–6 mm long and 0.1–0.2 mm wide, sparsely branched; exciple 3–5 striate, pale yellow to brown, uncarbonised, slightly carbonised only at the tips; ascospores 50–71×15–25 µm; stictic and constictic acids present .... ***H. epixanthum***

Hemithecium epixanthum (Mont. & Bosch) Chitale & Makhija, **comb. nov.**
MycoBank MB 512865 Figure 1
≡ *Graphis epixantha* Mont. & Bosch, Plant. Junghuhn, Fasc. 4: 472 (1855).

Thallus corticolous, crustose, smooth to cracked, olivaceous buff to citrine green, surrounded by a thin, black hypothallus. Ascomata lirelline, 2–6 mm long and 0.1–0.2 mm wide, simple to sparsely branched, immersed to semi-emergent, straight to curved, wavy, flexuous, concolorous with the thallus, with obtuse ends; thalline margin entire, raised, studded with crystals, encircling the exciple. Disc narrow, reddish brown. Proper exciple 3–5 striate, pale yellow to brown, slightly carbonised only at the tips, present at the base, converging at the apical portion, covered by a thick thalline margin up to the top; hymenium hyaline, not inspersed, 60–80 µm tall, I–, KI–; hypothecium hyaline, 12–17 µm thick; paraphyses simple; asci 8-spored. Ascospores hyaline, muriform, ovoid, oblong, 50–71×15–25 µm, I+ blue–violet.

Chemistry—Stictic and constictic acids present.

Additional specimens examined—Maharashtra, Ahmednagar District, Bhandardara, *G.S. Chitale & B.A. Adawadkar*, 02.162. Kolhapur District, Panhala, *P.G. Patwardhan & A.V. Prabhu*, 74.1051, 74.1070, 74.1077, 74.1081, 74.1088, 74.1093, 74.1109, 74.1112, 74.1114, 74.1117, 74.1125a, 74.1128, 74.1130; *U.V. Makhija & K.R Randive*, 00.380; Vishalgad, *M.B. Nagarkar & A.V. Prabhu*, 74.2169, 74.2181, 74.2190. Nasik District, Saptashringi Gad, *B.C. Behera & G.S. Chitale*, 02.180, 02.181, 02.182, 02.194. Pune District, Bhimashankar, *U.V. Makhija & B.A. Adawadkar*, 97.15, 97.18, 97.21, 97.23, 97.28; Khandala, Boma hill, *A.V. Prabhu, C.R. Kulkarni & M.B. Nagarkar*, 74.627, 74.628, 74.629; Lonavala, Walwan Dam, *B.C. Behera & B.A. Adawadkar*, 02.120; Purandar, *U.V. Makhija & A.V. Bhosale*, 02.54, 02.56, 02.57; Sinhagad, 16.8.2000, *U.V. Makhija & B.A. Adawadkar*, 00.48; Malshej Ghat, Neemgiri, 9.9.2002, *U.V. Makhija & A.V. Bhosale*, 02.12, 02.13, 02.15, 02.19, 02.23, 02.28. Raigad District, Hirdoshi, Bhor-Mahad road, *C.R. Kulkarni*, 74.1957, 74.1967, 74.1980. Ratnagari District, Chiplun, *G.S. Chitale;* Dabhole Ghat, *A.V. Prabhu & M.B. Nagarkar*, 74.2091; Gagan Bavda, *C.R. Kulkarni & A.V. Prabhu*, 74.1667. Sindhudurg District, Amboli, *C.R. Kulkarni & A.V. Prabhu*, 74.1385, 74.1389, 74.1391, 74.1416, 74.1421, 74.1422, 74.1433, 74.1437, 74.1438, 74.1441, 74.1442, 74.1485, 74.1555, 74.2280, 74.2281, 74.2290, 74.2319, 74.2362; *U.V. Makhija & K.R. Randive*, 00.211, 00.226, 00.272; Kasal, *U.V. Makhija & K.R. Randive*, 00.279, 00.244 -AMH.

Remarks—*Hemithecium epixanthum* exhibits a great variation in colour of the thallus, ascomata, and branching pattern but shows uniform internal morphology and chemistry in having stictic and constictic acids. This species was previously reported as *Graphina epixantha* (Mont. & Bosch) Zahlbr. (Patwardhan & Kulkarni 1976) from the western ghats of south India.

The species is found on the bark of the roadside trees in dry deciduous and semi-evergreen forests.

Hemithecium microspermum Chitale, Makhija, B.O. Sharma, **sp. nov.** FIGURE 2

MYCOBANK MB 512864

Species insignis ascosporis minoribus, muiformis, 17–21 x 8–14 µm; acida consticticum, norsticticum, sticticum et hyposalazinicum continens.

ETYMOLOGY: From the latin word *micro*, small, and *spermum*, seed, a reference to small ascospores.

Holotypus—India, Maharashtra, Kolhapur District, Vishalgad, 6.12.1974, *C.R. Kulkarni & P.G. Patwardhan,* 74.2234:AMH.

Thallus corticolous, crustose, greenish–gray, smooth, cracked with the age, delimited by a black hypothalloidal region at the periphery. Ascomata lirelline, semi-immersed, mostly simple to irregularly branched, flexuous, 1–7.5 mm long and 0.1–0.2 mm wide. Disc narrow, slit like, epruinose. Proper exciple concolorous with the thallus, convergent, entire or with 1–2 apical groves, uncarbonised. Hymenium hyaline, 63–80 µm tall, not inspersed; hypothecium hyaline, 17–21 µm thick; paraphyses simple; asci 6–8-spored. Ascospores hyaline, muriform, 5–6–trans-septate, 4–5 vertical septa, ellipsoidal, oblong, 17–21×8–14 µm, without halo, I+ violet.

CHEMISTRY—Constictic, hyposalazinic, norstictic and stictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Sindhudurg District, Amboli, *A.V. Prabhu & M.B. Nagarkar,* 74.2307-AMH

REMARKS—The new species *Hemithecium microspermum* is characterised by 1–7.5 mm long ascomata, uncarbonised exciple and hyaline, muriform, small ascospores of 17–21 × 8–14 µm in size and by the presence of constictic, hyposalazinic, norstictic and stictic acids in its thallus and thus stands distinct, amongst all the known species of this genus. The species has been collected in montane forest at higher elevation.

Externally *H. microspermum* is somewhat similar with *Fissurina rufula* (Mont.) Staiger, however *F. rufula* have 4–locular, hyaline ascospores.

Hemithecium multistriatum (Müll. Arg.) Chitale & Makhija, **comb. nov**. FIGURE 3

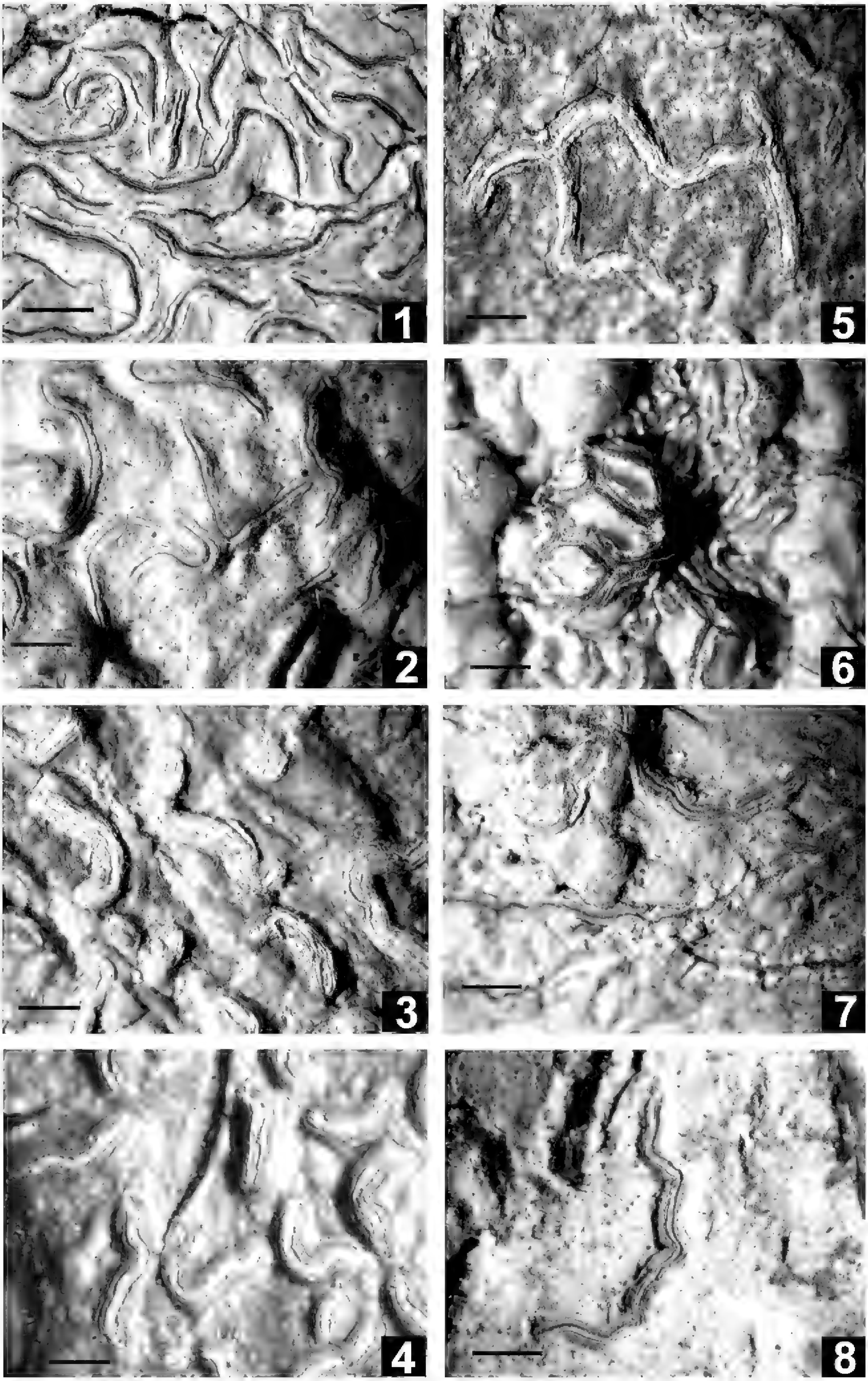
MYCOBANK MB 512866

≡ *Graphina multistriata* Müll. Arg., J. Linn. Soc., Bot. 29: 227 (1892).

Holotypus—India, Manipur, G. Watt, No. 85, Isotype – G (!).

Thallus corticolous, crustose, pale citrine to amber green, continuous, smooth; hypothallus distinctly black. Ascomata lirelline, distinctly emergent, pale woody brown to dull, cream coloured, straight to curved, flexuous, simple to rarely branched, tri-radiate, 1–7 mm long and 0.2–0.5 mm wide. Disc narrow slit like to open, pale. Proper exciple pale woody brown, to dull cream coloured,

FIGURES 1–8. Habit. 1. *Hemithecium epixanthum.* 2. *H. microspermum* (Holotype). 3. *H. multistriatum.* 4. *H. salacinilabiatum.* 5. *H. stictilabiatum.* 6. *Pallidogramme commutabilis.* 7. *P. indica* (Holotype). 8. *P. undulatolirellata* (Holotype). Bar = 1 mm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distinctly 4–5 striate, completely uncarbonised, present at the base. Hymenium hyaline, 150–250 µm tall, not inspersed; hypothecium hyaline, 13–20 µm thick; paraphyses simple, long slender; asci 1–2-spored. Ascospores hyaline, muriform, ellipsoid to fusiform, 150–200×60–75 µm, I+ violet.

Chemistry—No lichen substances present.

Additional specimens examined—Maharashtra, Sindhudurg District, Amboli to Sawantawadi, Road, Nanapali, *C. R. Kulkarni*, 74.2313, 74.2358-AMH.

Remarks—*Hemithecium multistriatum*, described by Müller (1892) from Manipur of India, can easily be distinguished by its conspicuous ascomata with emergent, pale woody brown, well developed multi-striate exciple, colourless, muriform, larger ascospores and no lichen substances in its thallus.

Pallidogramme chrysenteron (Mont.) Staiger et al., a species externally similar to *Hemithecium multistriatum* and the other two species of *Pallidogramme* namely *P. chlorocarpoides* (Nyl.) Staiger et al. and *P. chapadana* (Redinger) Staiger et al., differs from the present species in having brown, muriform ascospores and lichen substances.

Although Patwardhan & Kulkarni (1979b), while describing three new species of *Graphina multistriata* complex (i.e., *G. norlabiata, G. salacinilabiata, G. stictilabiata*) did not formally record the occurrence of *G. multistriata* from the western ghats of south India, they did include three photographs (Patwardhan & Kulkarni 1979b: plate 1, Fig. 1–3) of this species from Karnataka (AMH-74.3003), Kerala (AMH-76.355) and Maharashtra (AMH-74.2313).

Hemithecium multistriatum appears to be endemic to India where it is found on tree trunks in semi-evergreen and dry deciduous forests.

Hemithecium salacinilabiatum (Patw. & C.R. Kulk.) Chitale & Makhija, **comb. nov.** Figure 4

MycoBank MB 512867

≡ *Graphina salacinilabiata* Patw. & C.R. Kulk., Biovigyanam 5: 6 (1979).

Holotypus—India, Karnataka, Coorg, Talcauvary, *M.B. Nagarkar & A.V. Prabhu* 74.3333:AMH (!.)

Thallus corticolous, crustose, pale green to brownish green, continuous, smooth to unevenly thickened; hypothallus black. Ascomata lirelline, distinctly emergent, pale woody brown to dull cream coloured, straight to curved, flexuous, simple to rarely sparsely branched, 1–9 mm long and 0.2–0.5 mm wide. Disc narrow to open, cream coloured. Proper exciple woody brown, 4–5-striate, uncarbonised, present at the base. Hymenium hyaline, 150–220 µm tall, not inspersed; hypothecium hyaline, 12–21 µm thick; paraphyses simple; asci 1–2-spored. Ascospores hyaline, muriform, 130–200×35–60 µm, I+ violet.

Chemistry—Salazinic acid present.

Additional specimens examined—Maharashtra, Sindhudurg District, Amboli, *A. V. Prabhu & M. B. Nagarkar*, 74.2259.74.2358-AMH.

Remarks—*Hemithecium salacinilabiatum* can easily be distinguished from the closely related species *H. multistriatum* in having salazinic acid in its thallus. *H. multistriatum* has no lichen substances.

Hemithecium salacinilabiatum was described by Patwardhan & Kulkarni (1979b) as *Graphina salacinilabiata* from the western ghats of south India.

This species occurs in moist deciduous forests at an elev. 690 m.

Hemithecium stictilabiatum (Patw. & C.R. Kulk.) Chitale & Makhija, **comb. nov.**

MycoBank MB 512868 Figure 5

≡ *Graphina stictilabiata* Patw. & C.R. Kulk., Biovigyanam 5: 7 (1979).

Holotypus—India, Karnataka, South Canara, Rippon Peth–Tirthahalli road, *C.R. Kulkarni*. 74.2875:AMH (!).

Thallus corticolous, crustose, olivaceous green, continuous, smooth; hypothallus black. Ascomata lirelline, distinctly emergent, pale woody brown to dull, cream coloured, straight to curved, flexuous, simple to rarely with short branches, 1–10 mm long and 0.2–0.7 mm wide. Disc narrow slit-like to open, pale white. Proper exciple pale woody brown, 4–5 striate, completely uncarbonised, present at the base. Hymenium hyaline, 150–210 μm tall, not inspersed; hypothecium hyaline, 13–17 μm thick; paraphyses simple; asci 1–2-spored. Ascospores hyaline, muriform, 112–209×30–66 μm, I+ violet.

Chemistry—Stictic acid present.

Additional specimens examined—Maharashtra, Kolhapur District, Vishalgad, on the way from Amba to Gajapur, *C.R. Kulkarni & A.V. Prabhu*, 74.2196. Sindhudurg District, Amboli, *P.G. Patwardhan & M.B. Nagarkar*, 74.2258, 74.2310-AMH.

Remarks— Patwardhan & Kulkarni (1979b) described this species as *Graphina stictilabiata,* who also reported it from Maharashtra. *Hemithecium stictilabiatum* differs from the most closely related *H. multistriatum* (which lacks lichen substances) in having stictic acid in its thallus. The species has been collected in semi-evergreen forests.

Pallidogramme commutabilis (Kremp.) Chitale & Makhija, **comb. nov.**

MycoBank MB 512873 Figure 6

≡ *Graphis commutabilis* Kremp.,Nuov. Giorn. Bot. Ital. 7: 33 (1875).

Thallus corticolous, crustose, light orange yellow to yellowish brown, strongly warty, cracked, studded with crystals, thick, with a corticiform layer. Ascomata lirelline, concolourous with the thallus, immersed to semi-emergent, more or less aggregated in defused patches on the thallus, flexuous, 5–7 mm long, branched, rarely simple, terminally obtuse; thalline margin distinctly raised, concolorous with the thallus. Disc narrow slit-like. Proper exciple entire, non-striate, convergent, pale brown, uncarbonised or slightly carbonised at the tips. Hymenium hyaline, 90–126 μm tall, not inspersed, I–, KI–; hypothecium hyaline, 16–21 μm thick; paraphyses simple. Asci 4–8-spored. Ascospores

brown, muriform, ellipsoidal, with many transverse and vertical septa, 66–126 ×21–30 μm, I–.

Chemistry—No lichen substances present.

Additional specimens examined—Maharashtra, Satara District, Mahabaleshwar, Wilson point, *M.B. Nagarkar & A.V. Prabhu,* 73.2931-AMH.

Remarks—*Pallidogramme commutabilis*, a species originally described from Borneo, appears to be rather rare and is known in India from a single collection from Mahabaleshwar in Maharashtra, where it was found on the bark of a tree in semi-evergreen forest at an altitude of about 1400 m. This species was earlier reported as *Phaeographina commutabilis* (Kremp.) Zahlbr. by Patwardhan & Kulkarni (1979a).

Pallidogramme indica A. Dube & Makhija, **sp. nov.** Figure 7

MycoBank MB 512571

Similis Pallidogramme undulatolirellata*, sed lirellis longioribus (1–13 mm); excipulo non crenulato; ascosporis majoribus, 13–20-trans-septatis; et acida consticticum, sticticum continens differt.*

Etymology: From the country name India.

Holotypus—India, Maharashtra, Sindhudurg District, Amboli, 18.10.1974, *C.R. Kulkarni & A.V. Prabhu,* 74.1434:AMH.

Thallus corticolous, crustose, glaucous, yellowish–brown, epiphloeodal, smooth to rough, cracked with the age. Ascomata lirelline, concolorous with the thallus, flexuous, dendroidally branched, semi–emergent, terminally acute, 1–13 mm long and 0.3–0.7 mm wide. Disc narrow, slit like. Proper exciple brownish, entire, present at the base, uncarbonised, convergent. Hymenium hyaline, not inspersed, 77–140 μm tall, KI–; hypothecium hyaline, 18–35 μm thick; paraphyses simple; asci 2–8-spored. Ascospores hyaline to brown, fusiform–oblong, 13–20-trans-septate, 46–81×7–11 μm.

Chemistry—Stictic and constictic (trace) acids present.

Remarks—*Pallidogramme indica* is somewhat similar to the new species *P. undulatolirellata* (below) in appearance and in having brown ascospores but the two species are easily differentiated in the size of the ascomata, ascospores, and chemistry. *Pallidogramme undulatolirellata* has short (0.5–6 mm long), wavy lirellae, ascospores of 25–49×5–9 μm and a thallus with constictic, stictic, and norstictic acids whereas *P. indica* has longer lirellae (1–13 mm long), larger (46–81×7–11 μm) ascospores and a thallus with constictic (trace) and stictic acids.

Pallidogramme indica was collected at an altitude of 690 m in montane subtropical forests.

Pallidogramme undulatolirellata A. Dube & Makhija, **sp. nov.** FIGURE 8

MYCOBANK MB 512872

Similis Pallidogramme indica*, sed lirellis undulatus, brevioribus (0.5–6 mm); excipulo crenulato; ascosporis minoribus, 9–13 trans-septatis; et acida consticticum, sticticum et norsticticum continens differt.*

ETYMOLOGY: From the latin *undulatus*, wavy; *lirellatus*, lirellae or linear apothecia; a reference to nature of wavy lirellae.

Holotypus—India, Maharashtra, Kolhapur District, Panhala, 13.10.2000, *U.V. Makhija & K.R. Randive*, 00.392:AMH.

Thallus corticolous, crustose, buff to glaucous green, smooth, cracked with the age, delimited by a black hypothallus. Ascomata lirelline, concolorous with the thallus, short, highly wavy and curved, simple to sometimes dendroidally branched, semi-emergent to emergent, terminally acute, 0.5–6 mm long and 0.2–0.5 mm wide; thalline margin paler than the thallus. Disc narrow, dark reddish brown, 0.1–0.2 mm wide. Proper exciple reddish brown to blackish brown, 2–4 striate, present at the base, convergent, uncarbonised, sometimes blackish brown at the tips, covered by a thick thalline margin up to the top. Hymenium hyaline, not inspersed, 70–88 μm tall, I–, KI–; hypothecium hyaline, 14–18 μm thick; paraphyses simple; asci 4–8-spored. Ascospores brown, fusiform–oblong, 9–13-trans-septate, 25–49×5–9 μm, I–.

CHEMISTRY—Norstictic, stictic and constictic acids present.

ADDITIONAL SPECIMENS EXAMINED—Maharashtra, Kolhapur District, Amba, *C.R. Kulkarni & A.V. Prabhu*, 74.1255, 74.1263; *M.B. Nagarkar & A.V. Prabhu*, 74.2224. Sindhudurg District, Amboli, *C.R. Kulkarni & A.V. Prabhu*, 74.1408, 74.1411, 74.1651; Gaganbavda, *C.R. Kulkarni & A.V. Prabhu*, 74.1658, 74.1659, 74.1661-AMH.

REMARKS—In the present studies only two *Pallidogramme* species have been found with brown trans-septate ascospores. The new species, *P. undulatolirellata* resembles the new species *P. indica* (above) in having simple to dendroidally branched ascomata and convergent exciple but differs in chemistry and lirellae and ascospore sizes. *Pallidogramme undulatolirellata* has short, wavy lirellae (0.5–6 mm long), ascospores 9–13 trans-septate measuring 25–49×5–9 μm, and constictic, norstictic and stictic acids, whereas *P. indica* has larger (1–13 mm long) lirellae, ascospores 13–20–trans-septate measuring 46–81×7–11 μm, and constictic (trace) and stictic acids.

The specimens were collected in rain forests.

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Amanita magniverrucata—revision of an interesting species of *Amanita* section *Lepidella*

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This paper is dedicated to Dr. Cornelis Bas
on the occasion of the fortieth anniversary of the publication of
his groundbreaking thesis on *Amanita* and its section *Lepidella*.

Abstract—A revision is provided for *Amanita magniverrucata*, a species known from the state of California, USA, and reported from northern Baja California, Mexico. The universal veil appears to arise from the pileus context—without interposal of a pileipellis. The appropriate placement of *A. magniverrucata* in Bas' systematic scheme for *A.* sect. *Lepidella* is open to question. If the inflated cells of the volva are judged to be insufficiently elongate for placement in *Amanita* subsect. *Vittadiniae*, then a possible placement could be in *A.* subsect. *Solitariae*, within Bas' stirps *Microlepis*, in which the present species exhibits only limited phenetic similarity to previously assigned taxa. The present species may not be accommodated in the set of stirpes currently proposed for sect. *Lepidella*.

Key words—*Amanitaceae*, *Limacella*, North America, taxonomy.

Introduction

This paper is a continuation of taxonomic work on material of *Amanita* from the Pacific coastal regions of southwestern Canada, the Pacific coastal states of the USA, and northern Baja California. Previous papers on *Amanita* taxa of the same region have dealt with a revision (Tulloss & Lindgren 1992) of *A. smithiana* Bas (1969) and the proposal of two new taxa—*A. novinupta* Tulloss & J. Lindgr. (1994) and *A. aprica* J. Lindgr. & Tulloss (Tulloss & Lindgren 2005). Type studies of several regional taxa appear in (Tulloss 1994).

During revision of material of *A. magniverrucata*, it was noted that the universal veil appears to arise from the context of the pileus—without interposal of a pileipellis. This differs from the original interpretation of the same tissues in the species' protolog and subsequent publications, e.g., (Thiers 1982). This article focuses on morphological revision of *A. magniverrucata* and lays out concerns regarding its taxonomic placement.

Methods and materials

Methods used are those described, e.g., in (Tulloss 2000, 2008a).

(Kornerup & Wanscher 1978) is the source of color codes in the form of the following example: "4A6." Color names with first letters of words capitalized are from (Ridgway 1912). Munsell color notations (Anon. 1975) are in the form of the following example: 8.5YR 5.5/7.0. Munsell notational equivalents for Ridgway's names follow Hamly (1949).

Herbarium name abbreviations are conformant with (Holmgren et al. 1990), with the exception of "RET" (the author's herbarium).

Abbreviations in author citations follow Kirk & Ansell (1992, 2008).

Taxonomic part

Amanita magniverrucata Thiers & Ammirati, 1982. Mycotaxon 15: 161.

Figs. 1–3

=*Amanita strobiliformis sensu* Arora, 1979. Mushr. Demyst.: 236, illus.
Illus.: Thiers, 1982. *Amanitaceae*. Agaricales Calif.: pl. 29A.
Illus.: Arora, 1986. Mushr. Demyst., 2nd ed.: 274 & pl. 55.
Illus.: Jenkins, 1986. *Amanita* N. Amer.: fig. 85.
Illus.: Phillips, 1991. Mushr. N. Amer.: 23.
Illus.: Tulloss, 2008c. *Amanita magniverrucata*. in Tulloss & Yang, eds., Studies gen. *Amanita* Pers.

PILEUS: 60–156 mm wide, white to whitish at first, darkening slightly when bruised, becoming sordid yellowish-cream with gelatinization in senility, globose to convex becoming plano-convex to plane or shallowly depressed in age, with surface having dry dull appearance until age, then moist to subviscid in senility or if universal veil fissuring extending into context, with visible color that of universal veil at first, context sometimes visible in senility, lacking distinct pileipellis; *context* 8–30 mm thick at stipe, thinning evenly to margin, white, unchanging when cut or bruised, firm; *margin* nonstriate, strongly incurved at first, decurved at maturity, often strongly appendiculate (with flocculence from universal veil on marginal region and with substantial (often subpolygonal) pieces of partial veil); *universal veil* at first as thick and rather smooth covering of entire pileus, then becoming areolate, later as conspicuous pyramidal warts, large over disc and much of pileus at first, smaller or absent toward margins (even at first), fleshy, with surfaces longitudinally striatulate, further stretching and flattened or breaking up with further pileus expansion, white to tan to light brown (5–7D4–8) to Warm Buff (1Y7.8/6.0), becoming darker brown to reddish brown on tips, sometimes becoming brownish to pale

reddish brown (below brown tips) from disc outward, up to 20 mm wide at base and 10 mm high, adnate until age (but rather easily broken and then leaving irregular scar on remaining universal veil tissue), detersile in senility due to rather thick region of gelatinization apparently including both wart bases and upper pileus context (observed in Pastorino 1-21-05E).

LAMELLAE: narrowly adnate or shallowly notched at first, becoming free, with decurrent line on stipe at least until loss of partial veil material, subdistant to crowded, white to off-white to pale ivory to pale buff, 9± mm broad, with fimbriate margin, often with partial veil remnants attached, broadest at about 75% of distance from stipe to pileus margin; *lamellulae* subattenuate, unevenly distributed, of diverse lengths, plentiful.

STIPE: 28–120 × 10–34 mm, white to whitish, often with brown to reddish brown to buff stains, cylindric to subcylindric or narrowing upward, not flaring at apex, dry, glabrous above partial veil, appressed fibrillose to flocculose below, eventually becoming longitudinally striatulate at least in part; *bulb* 35–105 × 18–60 mm, dauciform or napiform at first (about equal in width to developing pileus in some "button" specimens), becoming less strongly differentiated from stipe as both diameters decrease during expansion of stipe, often with shallow vertical splitting in upper half, sometimes doglegged; *context* white, unchanging when cut or bruised, solid, dense; *partial veil* apical to superior, eventually breaking and tearing and (subsequently) lost or collapsing on stipe, white, submembranous to subfelted to floccose-fibrillose, with plentiful soft white cottony patches on underside; *universal veil* as scattered warts on stipe below partial veil and as one to 11 or more irregular or concentric rings (entire or comprising scales or warts) on upper bulb and lower stipe, white, becoming brownish or orange-brown with age, friable, often disappearing with age.

Odor indistinct at first, later strong and unpleasant. *Taste* mild.

MACROCHEMICAL TESTS: $FeSO_4$ - greenish then gray on pileus context (protologue). Spot test for tyrosinase (paracresol) - only minor reactions in bulb in "button" specimen. Spot test for laccase (syringaldazine) - negative throughout basidiome. [Chemical test voucher for phenoloxidases: Tulloss 11-24-89-D.]

PILEIPELLIS: poorly differentiated or absent. PILEUS CONTEXT: filamentous, undifferentiated hyphae 2.5–17.5 μm wide, branching, plentiful to dominating, curving, interwoven or tangled loosely, without dominant orientation, with thin to slightly thickened walls, sometimes with yellowish subrefractive walls; acrophysalides plentiful, clavate to fusiform to ellipsoid to ovoid to subpyriform, up to 85 × 38 μm or larger; vascular hyphae 3.8–16.8 μm wide,

Fig. 1. *Amanita magniverrucata*, habit. a. Buttons in early stage of expansion. Photogr. by D. Bojantchev (off Mt. Vision Rd., Point Reyes, Calif., elev. 200 m, with *Pinus muricata*, *Arctostaphylos manzanita*, and *Vaccinium ovatum*). < http://mushroomhobby.com/Gallery/Amanita/index.htm#Amanita_magniverrucata >. b. Expanded, but immature, specimens. Photogr. by R. Pastorino (with *P. muricata*, 21.i.2003 R. Pastorino s.n.)

Fig. 2. *Amanita magniverrucata*, habit, mature specimens (with *Pinus muricata* [not depicted], ca. Skyline Dr., Oakland, Calif., 9.ii.2003). Photograph by D. L. Viess.

branching, yellow-brown, scattered, locally common. LAMELLA TRAMA: bilateral; w_{cs} = 75–115 µm; with elements of subhymenial base [uninflated

and partially inflated hyphal segments and intercalary clavate cells (e.g., 32 × 16.5 μm, 41 × 15.0 μm)] diverging at angles up to 45° and concatenated in sweeping curve to subhymenium; filamentous, undifferentiated hyphae 3.2–11.0 μm wide, branching, with constrictions at some septa, with some intercalary segments slightly inflated; divergent, terminal inflated cells absent(?); vascular hyphae not observed; clamps infrequent. SUBHYMENIUM: w_{st}-near = 80–110 μm; w_{st}-far = 110–150 μm; comprising a branching structure of inflated cells (subglobose to pyriform nearest to subhymenial base and fusiform nearest basidia) and short uninflated hyphal segments, with elements having major diameter perpendicular to the central stratum for at least two cell lengths below bases of longest basidia, with basidia arising from uninflated or partially inflated hyphal segments or fusiform cells or very small subglobose inflated cells or branched elements (with varying degrees of inflation), with 2 to 2½ cells between bases of shortest and longest basidia; clamps infrequent. BASIDIA: 28–52 × 7.0–11.8 μm, thin-walled, dominantly 4-, but also occasionally 2- or 1-sterigmate; clamps and proliferated clamps infrequent, sometimes thin-walled and inconspicuous. UNIVERSAL VEIL: On pileus: with orientation of elements dominantly periclinal in base of wart but anticlinal or periclinal in upper part, with elements of lower part of wart dominantly hyaline and colorless and (at very base) arising from hyphae of dense upper portion of pileus context; with elements of upper part yellow-brown to orange-brown in mass (individually clouded and sordid yellowish to yellow to yellow-brown) and gelatinizing and somewhat disordered; filamentous, undifferentiated hyphae 3.5–19.5 μm wide, branching, common, occasionally with yellowish subrefractive walls, with those segments or parts of segments of largest diameter having slightly thickened walls; inflated cells dominating, terminal, singly or in short chains, with cells in such chains often easily dissociating, subglobose to ellipsoid to ovoid to clavate to broadly fusiform or subcylindric (with latter two forms the least common and restricted to smaller cells), up to 76 × 56 μm, with walls 0.5–1.0$^+$ μm thick; vascular hyphae 4.0–12.2 μm wide, sometimes brownish yellow, branching, unevenly distributed, locally common; clamps thin-walled, inconspicuous, infrequent. On stipe base, at top of bulb in immature specimen: very similar to material on pileus, with greater proportion of filamentous, undifferentiated hyphae, with some inflated cells brown, with inflated cells smaller (on average) than on pileus. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.8–11.0 μm wide, plentiful, branching, often in longitudinally oriented fascicles, occasionally with yellowish subrefractive walls, with walls thin or up to 1.0 μm thick; acrophysalides dominating, up to 203 × 55$^+$ μm, with walls thin or up to 0.5 μm thick; vascular hyphae not observed. PARTIAL

VEIL: filamentous, undifferentiated hyphae 3.2–8.0 µm wide, dominating, frequently branching, twisting and coiling, often in fascicles of rather few hyphae, sometimes with yellowish subrefractive walls, with walls thin to slightly thickened; inflated cells scattered, occurring more frequently in region adjacent to stipe surface, clavate, terminal (singly), up to 51 × 11.5 µm (but often about 60% of this size or less), with walls slightly thickened or up to 0.5 µm thick; vascular hyphae 6.0–9.0 µm wide, infrequent.

BASIDIOSPORES: [260/12/10] (6.5–) 8.0–12.6 (–15.5) × (4.5–) 5.8–8.0 (–9.5) µm, (**L** = 8.5–11.6 (–12.0) µm; **L'** = 10.3 µm; **W** = 6.0–7.4 (–7.5) µm; **W'** = 6.8 µm; Q = (1.17–) 1.31–1.79 (–3.75); **Q** = (1.39–) 1.41–1.66; **Q'** = 1.52), hyaline, colorless, thin-walled, smooth, amyloid, ellipsoid to elongate, rarely bacilliform or irregularly shaped in specimens with sporulation just beginning when dried, adaxially flattened, sometimes inflated at one end; apiculus sublateral, cylindric; contents mono- to multiguttulate; white in deposit.

ECOLOGY: Solitary to gregarious, apparently uncommon in some years throughout its range, but sometimes producing common fruitings (protolog). California: In coastal forests, with *Pinus muricata* D. Don and *Quercus agrifolia* Née or with *Quercus* and *Arbutus menziesii* Pursh or with *P. muricata* and *Arctostaphylos manzanita* Parry and *Vaccinium ovatum* Pursh or in dark loam under conifers. Possibly associated with similar trees in Baja California Norte, Mexico.

With regard to recovery after forest fire, the following was received from T.D. Bruns (UBC) (pers. comm., 10.vi.2008): "The ... [*A. magniverrucata* collecting] location on Limantour Rd in Pt Reyes burned in 1995, and the species disappeared from the site for over a decade. But this year we got several collections of it from the area again."

MATERIAL EXAMINED: **USA**: CALIFORNIA—Alameda Co. - Oakland, ca. Skyline Blvd., 20.i.2003 Mark Lockaby s.n. [Tulloss 1-20-03-A] (RET), 31.i.2003 Debbie Viess s.n. (RET). Marin Co. - ca. Bon Tempe Lk., 21.i.2005 Ron Pastorino 1-21-05E[1] (RET); Inverness Ridge, Chris Thayer & Phil Baird s.n. [Tulloss 11-24-89-D] (RET); Tomales Bay St. Pk., 21.i.2003 R. Pastorino s.n. (RET). Mendocino Co. - Mendocino, xi.1991 D. Arora 2001 (RET) & 2002 (RET). Santa Barbara Co. - Montecito, E. Valley Rd., 12.ii.1950 M. G. Rea F.11 (MICH); no locale, 21.iii.1944 P. M. Rea H.1341 (MICH). Santa Cruz Co. - Santa Cruz, 19.iii.1987 Marsha Heidt s.n. [H. D. Thiers 51203] (SFSU). San Mateo Co. - San Francisco Watershed, 13.iii.1970 Robert S. Keller 801 (SFSU, holotype; NY, isotype (n.v.)).

NOTES: This species was placed in *A.* sect. *Lepidella* when originally published; and, so far as I know, all subsequent authors treating the species have agreed (e.g., see the listed sources of illustrations, above). Within the cited

1. Collected as "button" and opened in vitro.

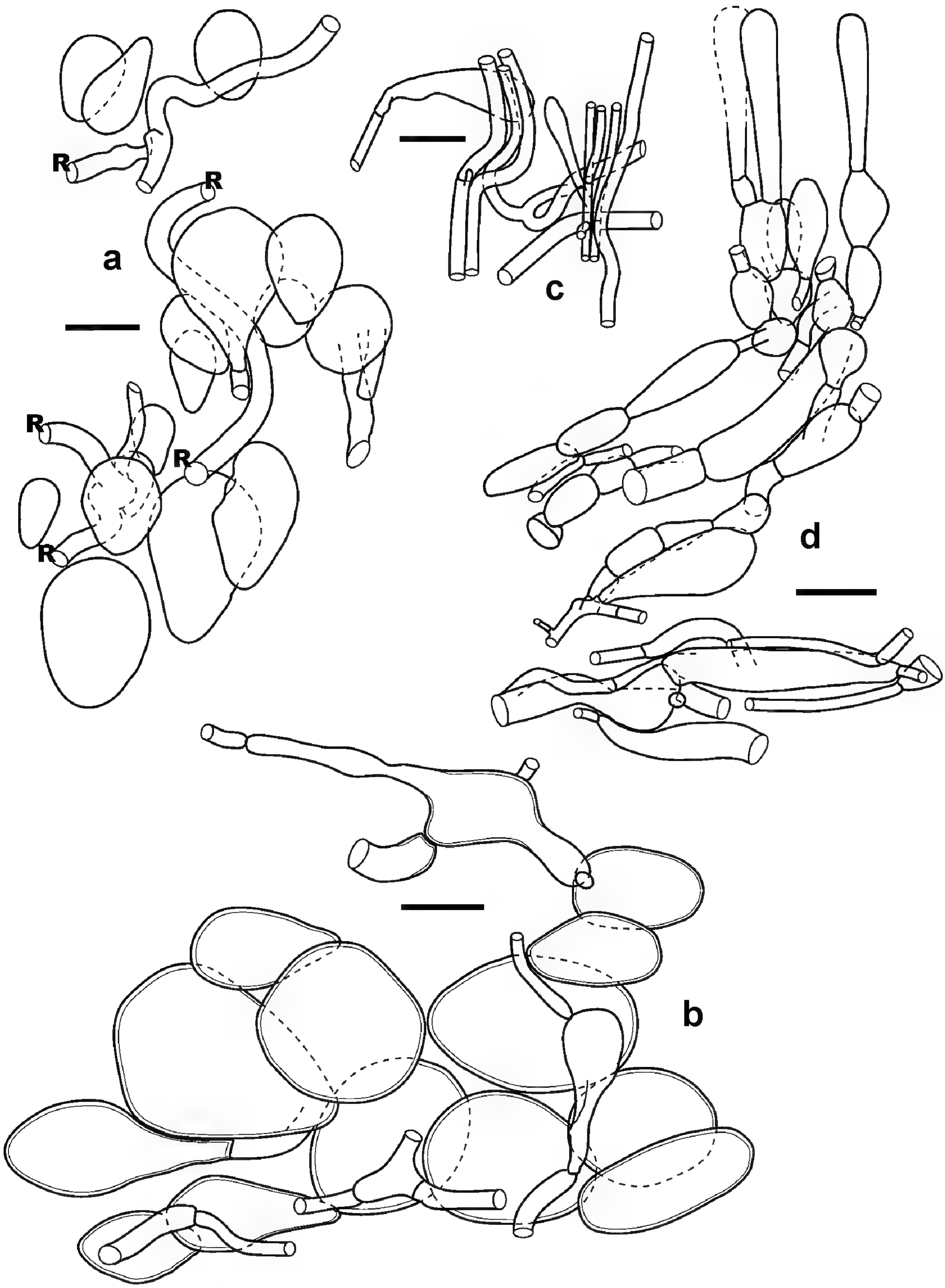

Fig. 3. *Amanita magniverrucata.* (a) Elements of universal veil on pileus, near exterior surface, thin-walled cells and anticlinal alignment (Tulloss 11-24-89-D). (b) Elements of universal veil from near base of wart, thickened cell walls and periclinal alignment (Thiers 51203). (c) Elements of partial veil (Thiers 51203). (d) Elements of hymenium, subhymenium, subhymenial base, and central stratum (Thiers 51203). "R" indicates an "end" of a refractive hypha. Scale bars = 20 µm.

section, placement in lower supraspecific ranks has not been attempted to the author's knowledge.

The protolog includes an apparent misinterpretation of the upper, denser part of the pileus context as a pileipellis, which was compounded by Thiers (1982: 29) who wrote: "pileus cuticle a trichodermium with terminal hyphal cells large and sausage shaped." While the description of the hyphae and acrophysalides are as in the protolog, the addition of the term "trichodermium" indicates that Thiers may have misinterpreted as a pileipellis that portion of the volva that often continues below the bottoms of the fissures that separate the warts.

By Bas' key (Bas 1969: 345), the present taxon could be placed in either *A.* subsect. *Solitariae* Bas (1969) or in *A.* subsect. *Vittadiniae* Bas (1969)—according to one's interpretation of the shape of the inflated cells of the volva. Other possibilities are eliminated because of (e.g.) the absence of an exterior, membranous layer in the universal veil of *A. magniverrucata*.

Placement within subsect. *Vittadiniae* would require interpretation of the basal cells of the volva as elongated and organized in chains. No other species in the subsection has cells of the shape illustrated in Fig. 3b. The absence of a pileipellis is very common (if not universal) in the known species of subsect. *Vittadiniae*. On the other hand, a scattering of taxa in other of Bas' subsections of *A.* sect. *Lepidella* also lack a pileipellis (see below).

The key to the stirpes within subsect. *Solitariae* (Bas 1969: 386–388) first requires knowledge of the presence or absence of clamp connections. Since, clamp connections were observed in multiple tissues of the material examined for this article, we are led to the choice of stirps *Microlepis* because the universal veil warts of the present species lack a "pad" dominated by hyphae at their bases and have their elements anticlinally oriented—at least in the upper portions of a wart..

One species placed by Bas (1969) within stirps *Microlepis* is of particular interest in terms of comparison to the present taxon—*A. abrupta* Peck (1897). This species' stipe has a subabrupt, napiform or turbinate bulb with continuous or occasionally broken, often rather finely delineated, concentric rings of universal veil tissue on its upper surface, somewhat mirroring the coarser concentric rings of volval material on the upper bulb of *A. magniverrucata*. The pyramidal, volval warts on the pileus of *A. abrupta* are much the largest of any of the other taxa Bas placed in stirps *Microlepis*. These pyramidal warts are (at first) connected to a pileipellis as little as 30 μm thick and lacking a noticeable, gelatinized suprapellis. *Amanita abrupta* differs from *A. magniverrucata* by having a distinct separation of universal veil from pileus context,

having notably more rapid loss of volval warts due to eventual gelatinization at the surface of the limited pileipellis, having a membranous and persistent partial veil, having smaller globose to subglobose spores, having surface fibrils of the stipe that are drawn upward (suggesting a cortina) on the underside of the partial veil, having a distribution limited to the eastern US, having an unusually strong and pervasive positive reaction to the syringaldazine spot test for the presence of laccase, etc. *Amanita sphaerobulbosa* Hongo (1969) is an east Asian taxon that appears to be quite similar to *A. abrupta*. Maintaining distinction between the two species is recommended by Yang & Doi (1999)—a position supported by the present author. *Amanita magniverrucata* is distinct from *A. sphaerobulbosa* by an argument similar to the one applied in the case of *A. abrupta*, above.

Arguments for either of the possible placements would require suppositions that do not seem entirely justified. The present species may be sufficiently unique to fail to fit into any of the stirpes Bas described. It seems preferable to await further evidence, perhaps from molecular studies.

The report of the present species from Mexico (Ayala et al. 1988) should be reinvestigated. The pileus on the material from Baja California is described as subviscid, the pyramidal warts are described as only 1 mm high (possibly a typographical error?), the partial veil is described as membranous, and the concentric rings of universal veil on the stipe's bulb are described as floccose.

In southern California, it may be possible to mistake *A. magniverrucata* for *A. subcaligata* (A.H. Sm. & P.M. Rea) A.H. Sm. ex Tulloss (Volk & Burdsall 1995) [=*A. salmonea* Thiers (1957) (Bas 1969: 360–361, figs. 45–47; Tulloss 2008b)] or vice versa because some specimens of the latter can have rather large warts on the pileus and many specimens have pinkish, orangish or rusty coloration, sometimes bruising to buff. However, *A. subcaligata* is clearly a species of *A.* subsect. *Vittadiniae* and can be distinguished from the present species by its having plentiful, concatenated, elongate inflated cells in the universal veil on the pileus.

Other taxa of section *Lepidella* that lack a well-formed pileipellis, are not assignable to subsect. *Vittadiniae*, and can easily be distinguished from the present taxon by Bas' keys (Bas 1969) include *A. rhoadsii* (Murrill) Murrill (1939) and *A. crassiconus* Bas nom. prov. (1969).

While a number of the new species described by Thiers & Ammirati (1982) originally were treated provisionally in unpublished MSc theses of Breckon (1968) and Nakamura (1965), the present species was not.

The present taxon has been called *A.* species C15 and *A.* species Vitt4 by the present author in old versions of regional keys and correspondence.

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A comparative study of the types of two nivicolous species of myxomycetes: *Lamproderma robustum* and *L. sauteri*

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Abstract — The type material of *Lamproderma robustum* was located, described, and typified. It was then compared with the holotype of *L. sauteri* and their synonymy confirmed. Spore ornamentation of both species was examined with the scanning electron microscope, and microphotographs that illustrate their most important characters are provided herein.

Key words — *Myxomycota*, *Stemonitales*, taxonomy

Introduction

An examination of type material is fundamental for knowing any species of myxomycete well, and this is especially true for the nivicolous myxomycetes that are characterized by wide morphological variation due to the extreme environmental conditions present during their development. These include low temperatures, frost, and abrupt changes in temperature and humidity when the snow melts.

However, locating a type specimen may be a difficult task, particularly when it is very old material. Sometimes its location has not been described in the literature or, if the author did cite a location in the original description, the material may have been moved. Additionally, access to a type may be restricted due to its age or scarcity of the material.

Therefore, investigators frequently turn to the original species description or subsequent descriptions made by other investigators who may not have actually examined the type specimen. Old descriptions often are rather short and their interpretation may be difficult and ambiguous. As a consequence, misinterpretations of taxa are carried on, as in the case of *Lamproderma cribrarioides* (Fr.) R.E. Fr., which had been misinterpreted since its description in 1829. The holotype of this species was examined by Singer et al. (2003) and found to correspond to a variety of *L. atrosporum* Meyl. (i.e., *L. atrosporum* var. *pseudocribrarioides* Mar. Mey. et al.) with completely reticulate spores. The

species attributed to the name *L. cribrarioides* was found to represent a new species — *L. retirugisporum* G. Moreno et al.— that had not yet been properly described.

The later study of *Lamproderma carestiae* (Ces. & De Not.) Meyl. by Poulain et al. (2003) revealed that in reality it represented another *L. atrosporum* variety with non-reticulate spores, i.e. *L. atrosporum* var. *atrosporum* (today: *Lamproderma cribrarioides* var. *carestiae* (Ces. & De Not.) G. Moreno & H. Singer). In this case, different investigators had interpreted *L. carestiae* in different ways, but these interpretations—as happened before—corresponded to new species: *L. zonatum* Mar. Mey. & Poulain (Poulain et al. 2003) and *L. aeneum* Mar. Mey. & Poulain (Poulain et al. 2002).

In the current work we examined the type of *Lamproderma robustum*, described more than a century ago in 1884, and differently interpreted by later investigators who also studied the type material but proposed two very different species as synonyms: *Lamproderma atrosporum* (Dennison 1945) and *L. sauteri* (Lister 1894). Although most myxomycetologists now follow Lister's interpretation, the type material has not been examined again until now, and for the first time scanning electron microscopy has been used to examine the spore ornamentation.

Materials and methods

The examined specimens come from the herbaria NY and STR.

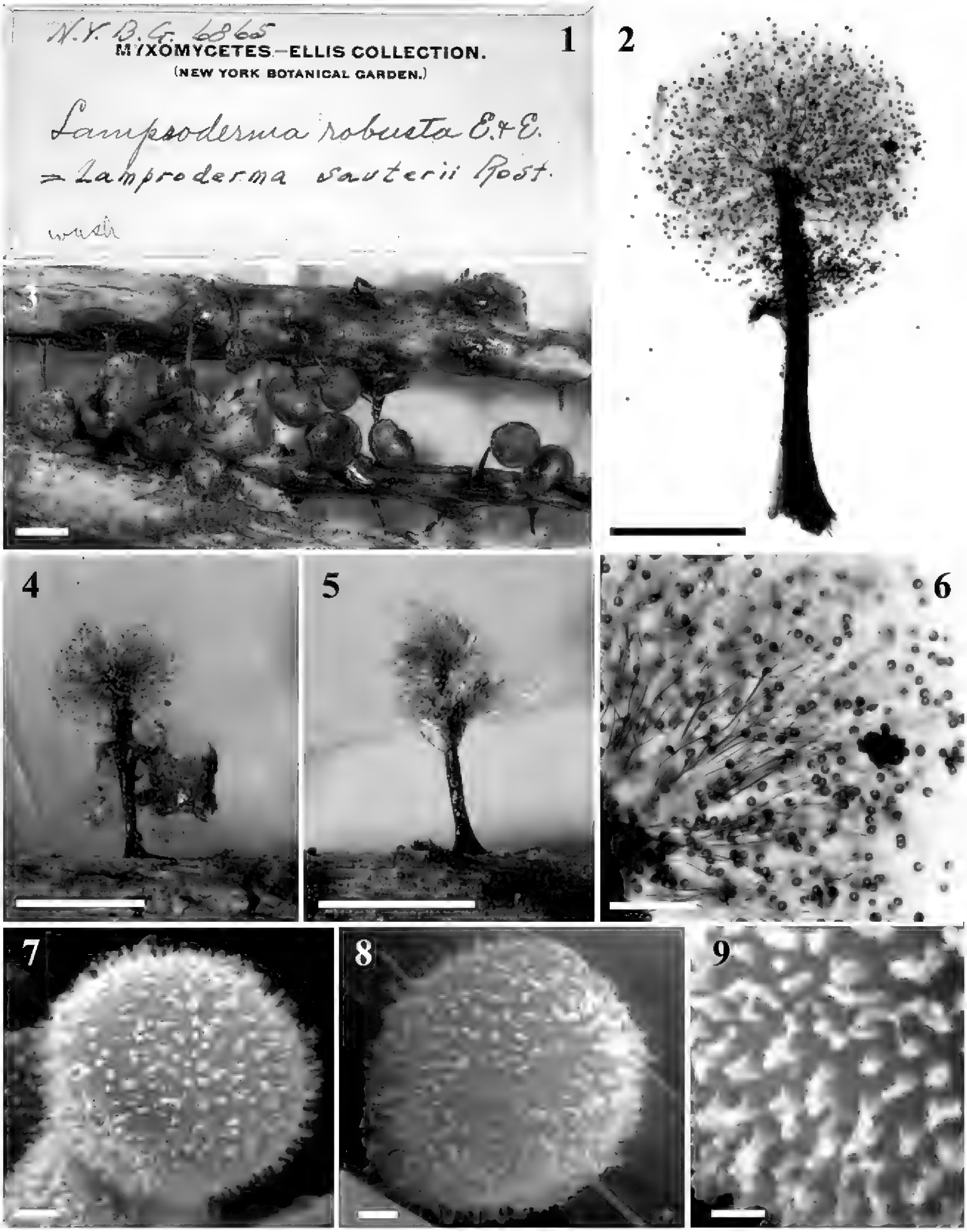
Specimens were mounted in Hoyer's medium and studied with a Nikon microscope. Scanning electron microscopy micrographs were made with a Zeiss DSM-950. Spore measurements were made under the oil immersion objective and include surface structures such as spines or warts.

For ultramicroscopic studies the material was rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1,2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours followed by critical point drying and sputtering with gold-palladium.

Taxonomic description

Lamproderma robustum Ellis & Everh., Bull. Washburn Lab. Nat. Hist. 1: 5 (1884) **Figs. 1–9**

Original diagnosis — Sporangia stipitate, gregarious, globose, 1 mm in diameter, with double walls, the outer wall of which is thin, membranaceous, transparent, and soon falls away, while the inner one is quite permanent, and is of a dull, olivaceous, metallic gray, without lustre; stem stout, black 1 mm high, arising from a distinct, membranaceous hypothallus, and penetrating as a columella to near the center of the sporangium, where it is slightly thickened, and sends out on all sides abundant stout,



Figs. 1–9. *Lamproderma robustum* (holotype). **1.** Herbarium box. **2, 4, 5.** Detail of sporocarp. **3.** Group of sporocarps. **6.** Detail of capillitium. **7–8.** Spores. **9.** Detail of spore ornamentation. Scale bars. 2 = 0.5 mm. 3–5 = 1 mm. 6 = 150 µm. 7–8 = 2 µm. 9 = 1 µm.

branching, olive-brown threads, which combine into a dense net-work; spores snuff-brown, globose, strongly and densely warted, 11.5–13 µm.

Specimens examined — UNITED STATES. — **Washington, Yakima Co.**, Mt. Adams (Mt. Paddo), on woody branches of *Ericameria bloomeri* (A. Gray) J.F. Macbr., IX-1883,

leg. Suksdorf, Nº 47 in *NY 6865* (**HOLOTYPE**), *NY 6863* (**ISOTYPE**). **Kitsap Co.**, Chico, ex Herb. Macbride, Sturgis collection in *NYBG 11332* as "*Lamproderma robustum = L. violaceum* var. *sauteri*", is ***Lamproderma sauteri.*** Ibidem, *NY 11333* as "*Lamproderma robustum = L. violaceum* var. *sauteri*", is ***Lamproderma sauteri.*** — **CALIFORNIA, Idyllwild Co.**, on *Ribes* stems, 24-III-1928, leg. and det. O.A. Plunkett, Southern California *Myxomycetes* nº 232 in *NY* without number: "*Lamproderma robustum = L. sauteri*", is ***Lamproderma cucumer.*** **Fresno Co.**, Summit Meadow, near Shaver Lake, ca. 1768 m (5800 ft), on twigs of *Ribes roezlii* Regel, 4-X-1965, leg. D.R. Miller & Bill Paldi, det. Lee Bonar, California Fungi in *NY* without number, as "*L. robustum* Ell. & Ev. (= *L. atrosporum* Meylan)", is ***Lamproderma cucumer*: San Bernardino Co.**, Big Bear Lake, on fallen pine needles, living leaves, 29-V-1927, leg. and det O.A. Plunkett, Southern California *Myxomycetes* nº 217 in *NY* without number, as "*Lamproderma robustum = L. sauteri*", is ***Lamproderma echinosporum.***

DESCRIPTION — The type material is distributed in two cardboard boxes. We consider the specimen NY 6865 the holotype of the species (FIG. 1), as the information provided inside the box corresponds with the data indicated in the original diagnosis by Ellis & Everhart (1884). The specimen is very abundant and there are numerous pieces of twigs plentifully covered with sporocarps stuck to the inner side of the upper box lid and the small laterals of the lower part of the box, in the centre of which a handwritten note is stuck with a large "47" written in blue ink and the following text in black: "*Lamproderma robusta* E. & E., on woody branches of *Aplopappus bloomeri*, Mt. Paddo W.T., Sept. 83. W.N.S., Dr. Rex thinks this is *L. arcyrioides*". Quite a few of the sporocarps are collapsed or old, but others are in rather good condition. We regard the collection NY 6863 as an isotype, which is less copious and consists of only three small pieces of twigs of *Ericameria bloomeri* fixed to the inner side of the upper box lid, bearing many very well fructified sporocarps. In the lower part of the box there is a rectangular peace of wood with a label stuck on it containing the following information handwritten with India ink: "*Lamproderma robusta* Ell. & Evrht., on twigs of *Aplopappus bloomeri*, Mt. Paddo Washington, Sept. 1883. W.N. Suksdorf".

We provide the following description of the holotype:

Sporocarps gregarious to aggregated, stalked, 1.5–2 mm total height. Sporotheca (FIGS. 2–5) globose, 0.7–1.2 mm diam., iridescent with blue, violaceous or bronze reflections. Hypothallus membranous, reddish brown, common to several sporocarps. Stalk same height as sporotheca or 1.5 times its diameter, widened in the base, blackish by magnifying glass. Peridium simple, irregular dehiscence, breaking easily and persisting in the base. Columella reaching half the height of the sporotheca, cylindrical or tapering toward the apex, blackish by light microscope (LM). Capillitium (FIG. 6) radial, originating in the upper part of the columella, moderately branched in the center of the sporotheca, more branched towards the periphery, reddish brown to dark reddish, clearer and thinner towards the outside. Spores (FIGS. 7–8) globose, 13.5–14.5(–15) µm diam., dark brown in mass, dark violaceous with a clearer zone by LM, spiny.

When examined with the scanning electron microscope (SEM), densely and regularly distributed baculae can be observed (FIG. 9).

COMMENTS — We agree almost completely with the original description, with the exception of the color of the different portions of the sporocarp—possibly due to the subjectivity of the observer—the presence of a double peridium—absent in the genus *Lamproderma* that always has a single membranous peridium—and spore size, 13.5–14.5(–15) µm diam. according to our observations and 11.5–13 µm in the original description.

It calls our attention that the type specimens were collected in September, because the majority of the nivicolous myxomycetes are found in spring, when snow melts in the mountains, which—depending on the elevation—can last until the summer months of July or August. But we have to take into account that the site of collection, Mount Adams (referred to as Mount Pahto by the natives and Mt. Paddo by Suksdorf) is a high volcano (3742 m), the upper cone of which is covered by ice (mostly in the form of glaciers) and is fed by ample snowfall every year, which would explain why these specimens were gathered in autumn. Furthermore, it is possible that we are dealing it with an old fructification that had developed in late summer and was not picked up until September. This would explain the rather poor condition of the specimens.

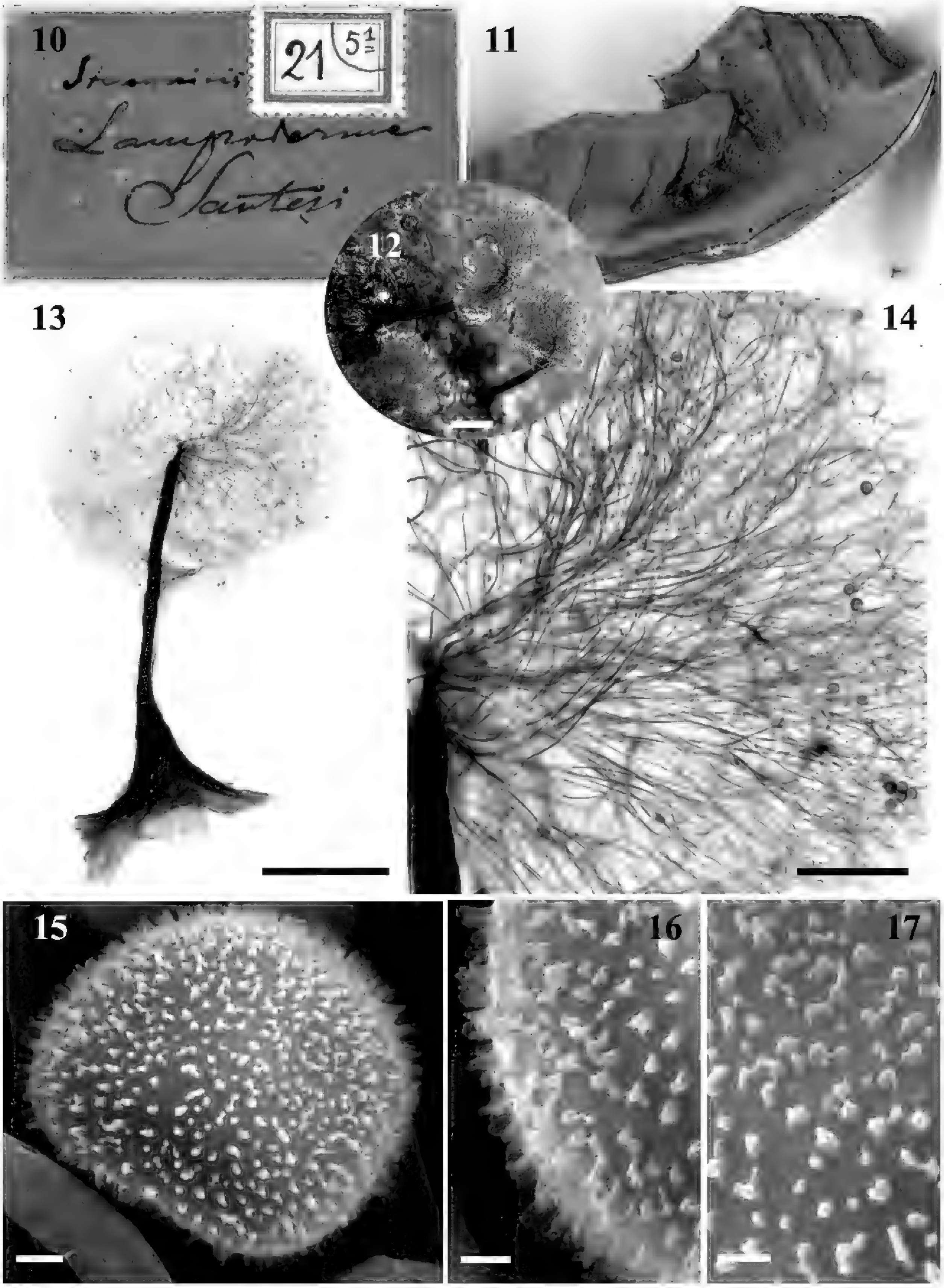
The substrate is *Ericameria bloomeri* (A. Gray) J.F. Macbr. (rabbitbush) (≡ *Haplopappus ["Aploppapus"] bloomeri* A. Gray), a many-branched shrub reaching a maximum height of about half a meter that is native to the mountains of western North America where it grows in coniferous forests up to approximately 1800 m.

Lamproderma sauteri Rostaf., Sluzowce Monogr.: 205 (1874) **FIGS. 10–17**

ORIGINAL DIAGNOSIS — English translation from Polish original description: Similar to the previous species (*Lamproderma violaceum*), more robust in all its elements. The sporangia are globose, slightly flattened towards the base, 1 mm broad, shiny, with a metallic iridescence. Stalks black, shiny, originating from a common, very well developed and robust hypothallus; the stalks turn inside the sporangium in an exactly cylindrical columella, truncate at the apex. The filaments of the capillitium are much branched, they frequently divide, almost from its base, forming a very dense net. Capillitium light brown after spore dispersion. Height of the sporangium, including stalk, 2 mm. Spores dark violaceous, very spiny, 12.5–15 µm, large.

SPECIMENS EXAMINED — **AUSTRIA, SALZBURG**, 1863, on frond of *Phyllitis scolopendrium* (L.) Newman (≡ *Asplenium scolopendrium* L.), herb. Rostafinski 21-51 in *STR* without number (**HOLOTYPE**).

DESCRIPTION — The type material is kept in a small cardboard box, which bears a stamp on its outer side with the numbers 21 and 51 handwritten with black ink (FIG. 10). In the inside of the box there is card with a part of a fern frond with sori of *Phyllitis scolopendrium* stuck on it (Fig. 11). The sporocarps



Figs. 10–17. ***Lamproderma sauteri*** **(holotype). 10.** Herbarium box. **11.** Fern frond with sori. **12.** Group of sporocarps on sori. **13.** Detail of sporocarp. **14.** Detail of capillitium. **15.** Spore. **16–17.** Detail of spore ornamentation.

Scale bars. 12–13 = 0.5 mm. 14 = 150 µm. 15 = 2 µm. 16–17 = 1 µm.

are few in number, almost entirely lack a peridium and spores, and can be found primarily between the sporangia of the sori. The macro- and microscopic description is identical to the description provided for *Lamproderma robustum*, with the following differences in measurements and colors: Sporotheca (Figs. 12–13) 0.8–1.5 mm diam. Capillitium (Fig. 14) reddish-brown to orangeish, clearer towards the periphery. Spores (Figs. 15–17) 13–16 µm diam.

Comments — *Lamproderma sauteri* has been cited from Spain and described by Moreno et al. (2003). Later, Poulain et al. (2003) studied the holotype of this species, which has been reexamined by us. There are no significant differences between our observations and the original description of the species.

Discussion and conclusions

According to the information available in the literature, Massee (1892) was the first to reexamine the type of *Lamproderma robustum* after its description in 1884. He studied a portion of the type provided to him by Mr. Wingate and observed minutely warted spores, 9–10 µm diam., separating it from *L. sauteri* with its larger spores, 12–15 µm diam., densely covered with spinules.

Lister (1893), in his monograph on the myxomycetes, studied the same type portion already examined by Massee but disagreed with Massee's observation, noting instead strongly spinulose spores, 11–13 µm diam., and considering it "almost identical with the type of *Lamproderma sauteri*." Lister considered both species to represent a variety of *L. violaceum*, which he named *L. violaceum* var. *sauteri* (Rostaf.) Lister, characterized by a brown capillitium, spores 11–15 µm diam, and nearly smooth or spinose. He retained this view in both the second and third editions of his work (Lister 1911, Lister & Lister 1925).

Macbride (1899), in the first edition of his monograph Myxomycetes of North America, treated the two species *Lamproderma robustum* and *L. sauteri* as synonyms. In the second edition of his work (Macbride 1922), however, he emphasized that *L. robustum* differed from *L. sauteri* and was "well defined, not a variety of anything", making a clear reference to Lister's proposed variety, *L. violaceum* var. *sauteri*. Macbride (1922) here characterized *L. robustum* principally by its persistent basal peridium, its very dense and much branched capillitium forming a delicate network with abundant free ends in the surface, and large (14–16 µm diam) spores.

Graff (1928) created the variety *Lamproderma sauteri* var. *robustum* (Ellis & Everh.) P.W. Graff, based on a collection on *Pinus ponderosa* Dougl. from northwestern Montana in the United States. Graff regarded this variety as being very close to *L. sauteri*, "too close (…) to be considered separate from it, but distinct enough for varietal status," and characterized it by a much branched capillitium, dark to purplish brown, forming a fine-meshed network in the

surface and minutely echinulate, 12–15 µm diam. spores.

Dennison (1945) compared type material of *Lamproderma robustum* with collections of *L. atrosporum* (currently recognized as *Lamproderma cribrarioides* var. *carestiae* from Switzerland) and considered them "identical in essential respects" for sharing widened capillitium terminations, spores of similar size, color and ornamentation, the same general structure and growth habit. Because *L. robustum* is the older name, he maintained it, treating *L. atrosporum* as a synonym. Dennison distinguished *L. robustum* from *L. sauteri* by its dark spores with a warty ornamentation tending to form a reticulum and the widening of the capillitium tips.

Martin & Alexopoulos (1969) cited *Lamproderma robustum* as a synonym of *L. sauteri*, as did Kowalski (1970) in his monograph on the genus *Lamproderma*. Today, Hernández-Crespo & Lado (2008) follow the same taxonomic treatment.

In conclusion, the several investigators who studied the type material of *Lamproderma robustum* have come to different conclusions. While Massee (1892) and Macbride (1922) corroborated that it is an independent species, the first one giving spore characters that we have not been able to confirm, Lister (1893) considered the two species *L. robustum* and *L. sauteri* to represent a variety of *L. violaceum* Fr. ex Rostaf. The interpretation by Dennison (1945) is especially noteworthy, as *L. robustum* has nothing in common with *Lamproderma cribrarioides* var. *carestiae*. Therefore, we doubt that Dennison actually studied authentic type material of *L. robustum*.

We have examined other specimens deposited in the herbarium NY and determined as *Lamproderma robustum*, among them two collections from the Macbride herbarium (NY 11332 and NY 11333), which consist of limited material but are excellently conserved. The Macbride specimens correspond without doubt to large-stalked *L. sauteri*, described by Meylan as *L. sauteri* f. *gracile* Meyl. Contradictorily, Macbride described *L. robustum* in his monograph with a short stalk (Macbride 1899, 1922). However, Martin & Alexopoulos (1969) had already pointed out that adverse environmental conditions during fructification development may cause excessively large stalks and we consider these long stalked forms as lacking taxonomic significance.

The two specimens determined by O.A. Plunkett as *Lamproderma robustum* belong to two different *Lamproderma* species. Collection #217, which has globose sporothecae, a mottled peridium, a dark radial capillitium and spores 13–15 µm diam., with a strong spiny to shortly crested, lax spore ornamentation, represents *L. echinosporum* Meyl. Specimen #232 shows an ovoid to ellipsoid sporotheca, very short stalk, dark abundant capillitium with straight branches and dark expansions at the branching points, and 12–13 µm diam. spores that are densely covered by small warts. It corresponds to *L. cucumer* (Meyl.)

Nowotny & H. Neubert. The collection without a number determined by Lee Bonar as *L. robustum* presents the same characters as Specimen #232 and corresponds as well to *L. cucumer.*

Acknowledgments

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Echinosphaeria pteridis sp. nov. and its *Vermiculariopsiella* anamorph

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Abstract – *Echinosphaeria pteridis* sp. nov. and its anamorph, *Vermiculariopsiella pteridis* sp. nov., was isolated as an endophyte from a pteridophyte, *Pteris vittata*, collected from the Western Ghats in India. This is the second report of culture-based teleomorph-anamorph connection in *Vermiculariopsiella*.

Key words – biodiversity, fungi

Introduction

During studies of microfungi of the Western Ghats in southern India (Keshavaprasad et al. 2003, Gawas et al. 2006, Pratibha & Bhat 2008), an interesting endophyte was isolated from the fresh rachis of a pteridophyte, *Pteris vittata* L. (family: *Pteridaceae*), collected from Gersoppa, Uttara Kannada District, Karnataka State. After isolation into pure culture, the fungus first produced a sporodochial anamorph within 7 days. A further 15 days of incubation at 23–25°C led to the development of perithecia in small groups on tiny stromata amongst the sporodochia. The anamorph was identified as a new species of *Vermiculariopsiella* Bender (Bender 1932). The teleomorph was similar to *Echinosphaeria* A.N. Mill. & Huhndorf (Miller & Huhndorf 2004), but differed from the two known species (Gawas et al. 2006).

Materials and methods

Fresh and apparently disease-free rachises of *Pteris vittata* were processed for endophytes as described by Sati & Belwal (2005). The rachises were surface sterilized in 0.01% sodium hypochlorite (3–6 min) followed by 96% ethanol (30 s). The surface sterilized rachises were thoroughly rinsed thrice in sterile distilled water to remove all traces of surface sterilizing agents, cut into 0.1–0.5 cm pieces using a sharp sterile blade and plated on 2% malt extract agar (MEA, Himedia) plates with a mixture of antibiotics (bacitracin 20 mg, neomycin 20

mg, penicillin 20 mg, streptomycin 20 mg and tetramycin 40 mg dissolved in 10 mL of sterile distilled water added to 1 L of MEA medium). The mycelia emerging from the cut ends of the rachises were transferred onto fresh MEA plates (Borosil, 9 cm diam.). The plates were incubated at 23–25°C in diurnal light for several weeks until sporulation occurred.

Standard Deviation was calculated using statistical tools of Microsoft Excel.

Confirmation of anamorph-teleomorph connection

A sporodochium and perithecium, which developed in culture, were aseptically transferred onto separate flame sterilized slides and dissected in a drop of sterile distilled water to prepare spore suspension. The suspension was spread onto the surface of 2% malt extract agar plates. Germinated spores were aseptically transferred onto fresh MEA plates, incubated at 25°C until growth and sporulation occurred. The development of anamorph and teleomorph in culture arising from both conidia and ascospores were in conformity with *Vermiculariopsiella pteridis* and *Echinosphaeria pteridis.*

Taxonomy

Echinosphaeria pteridis S. Dharg. & Bhat, **sp. nov.** (Fig. 1–3, 7)
MycoBank MB 512784

anamorph —***Vermiculariopsiella pteridis*** S. Dharg. & Bhat, **sp. nov.** (Fig. 4–6, 8)
MycoBank MB 512869

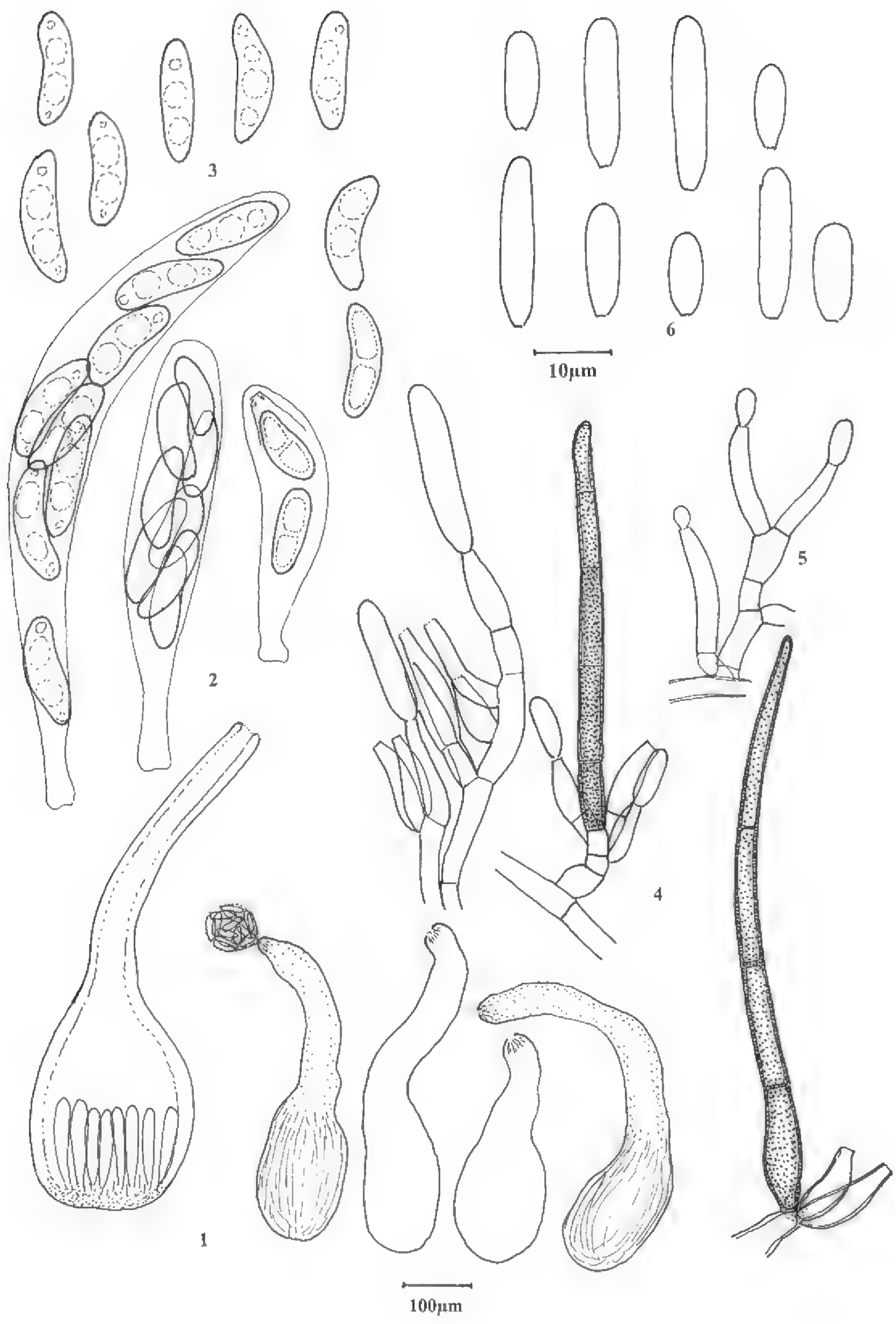
In MEA-cultura, coloniae 6–8 cm diametro in 10 dies. Ascocarpis 350–620 × 65–130 µm, collum 145–430 µm longus, 50–60 µm latum, 100 µm latum ad basim, pallide brunnea, glabratus. Asci octospori, 23–70 × 8–15 µm. Ascosporae aseptatae, laevia, hyalinae vel pallide brunneae, 10–23 × 4–8.5 µm, allantoideae vel ovalis, teres ad duo extremitas, interdum cum duo extremitas apiculata.

Anamorphosis: Conidiomata sporodochia, 580–1115 × 400–1015 µm, conidis agglutinates, cremea vel persicinus. Setae atro-brunnea, 40–145 µm longae, 1.5–3.5 µm latis ad medius, 2–6.5 µm latis ad pessum. Conidiophora parce ramosa, hyalina vel pallide brunae, 8–74 × 3–4.5 µm. Cellulae conidiogenae monophialideae, hyalinae, cylindricae vel lageniformes, 7–40 × 3–4.5 µm, sine emineo collarettae. Conidia aseptata, hyalina, oblongus vel cylindrica, 10–27 × 4–5.5 µm.

Holotype: On rachis of *Pteris vittata* as endophyte, Gersoppa, Western Ghats, Karnataka, India, 03-XII-2007, S. Dhargalkar, dried culture mat GUBH SD-469, Herb. No. HCIO 48775.

Etymology: Refers to the pteridophyte host genus, *Pteris*

Colonies on MEA after 10 days effuse, smooth, flat, cottony, moderate to fast growing, attaining a diam. of 6–8 cm, at first producing slimy sporodochial conidiomata, later with ascomata developing in groups on stromatic bases; margin fringed, off-white later turning grayish; reverse off-white. Mycelium superficial, with branched, septate, smooth, hyaline, hyphae 2–2.5 µm wide.



Figs. 1–3. *Echinosphaeria pteridis.* Ascocarp, asci, ascospores. Figs. 4–6. *Vermiculariopsiella pteridis.* Sporodochia with setae, conidiophores, conidiogenous cells and conidia.

Teleomorph: Ascomata perithecial, aggregated in groups on stromatic bases, pyriform, ostiolate, dark brown, 350–620 × 65–130 µm, with a conspicuous long neck bearing apical ostiole; neck pale brown, glabrous, 145–430 µm long, 50–60 µm wide above, up to 100 µm wide at the base. Asci unitunicate, 8-

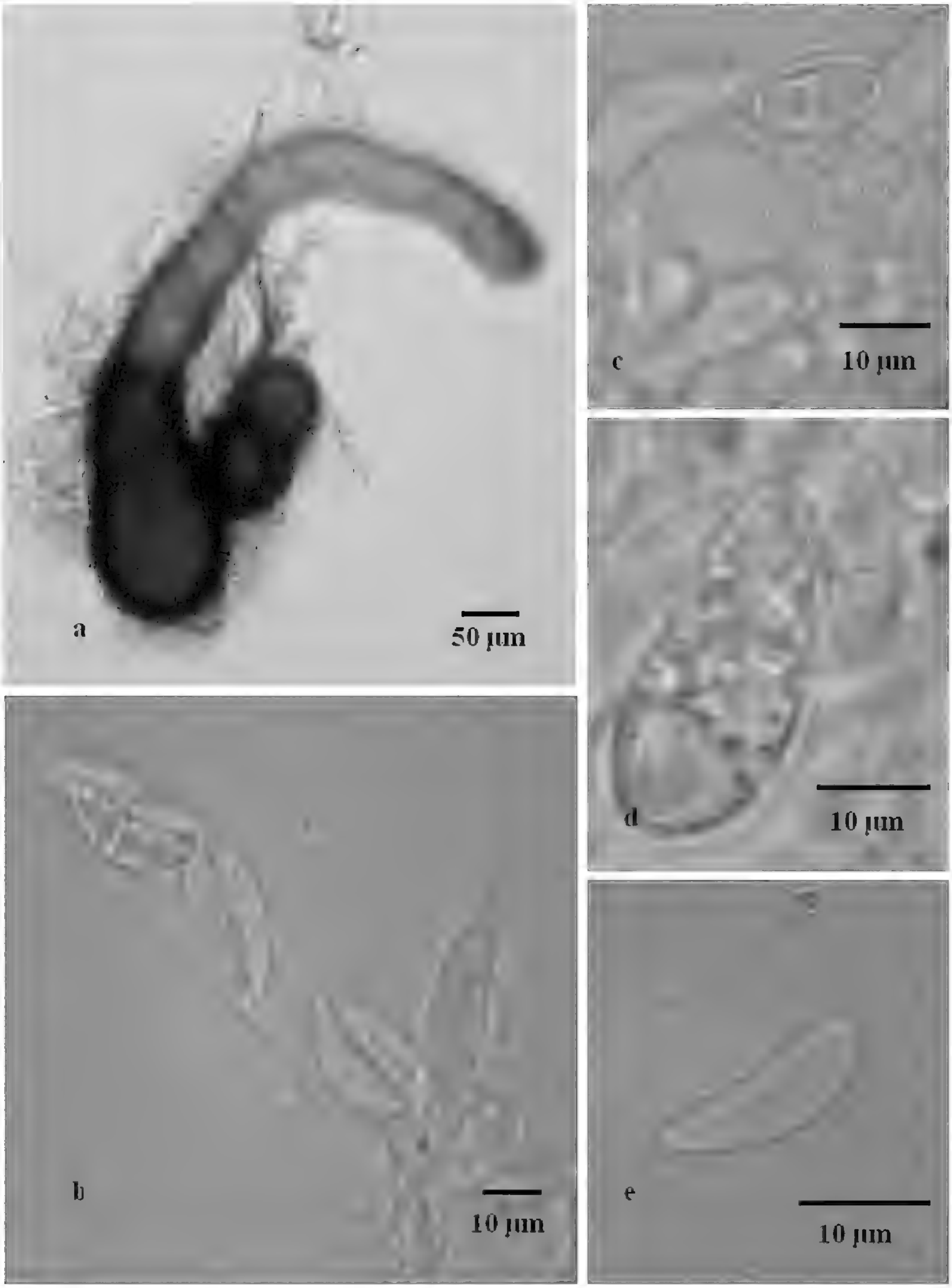


FIG. 7. *Echinosphaeria pteridis* a. ascocarp; b. ascus with biseriately arranged ascospores; c. immature ascus with conspicuous apical ring; d,e. ascospores.

spored, clavate, rarely ovoid, 23–70 × 8–15 µm, slightly narrower towards the tip, pedicellate, non-amyloid, with a conspicuous apical ring. PARAPHYSES absent. ASCOSPORES aseptate, allantoid to oval, rounded at both ends, sometimes with slightly pointed ends, smooth, hyaline, turning pale brown with age, guttulate,

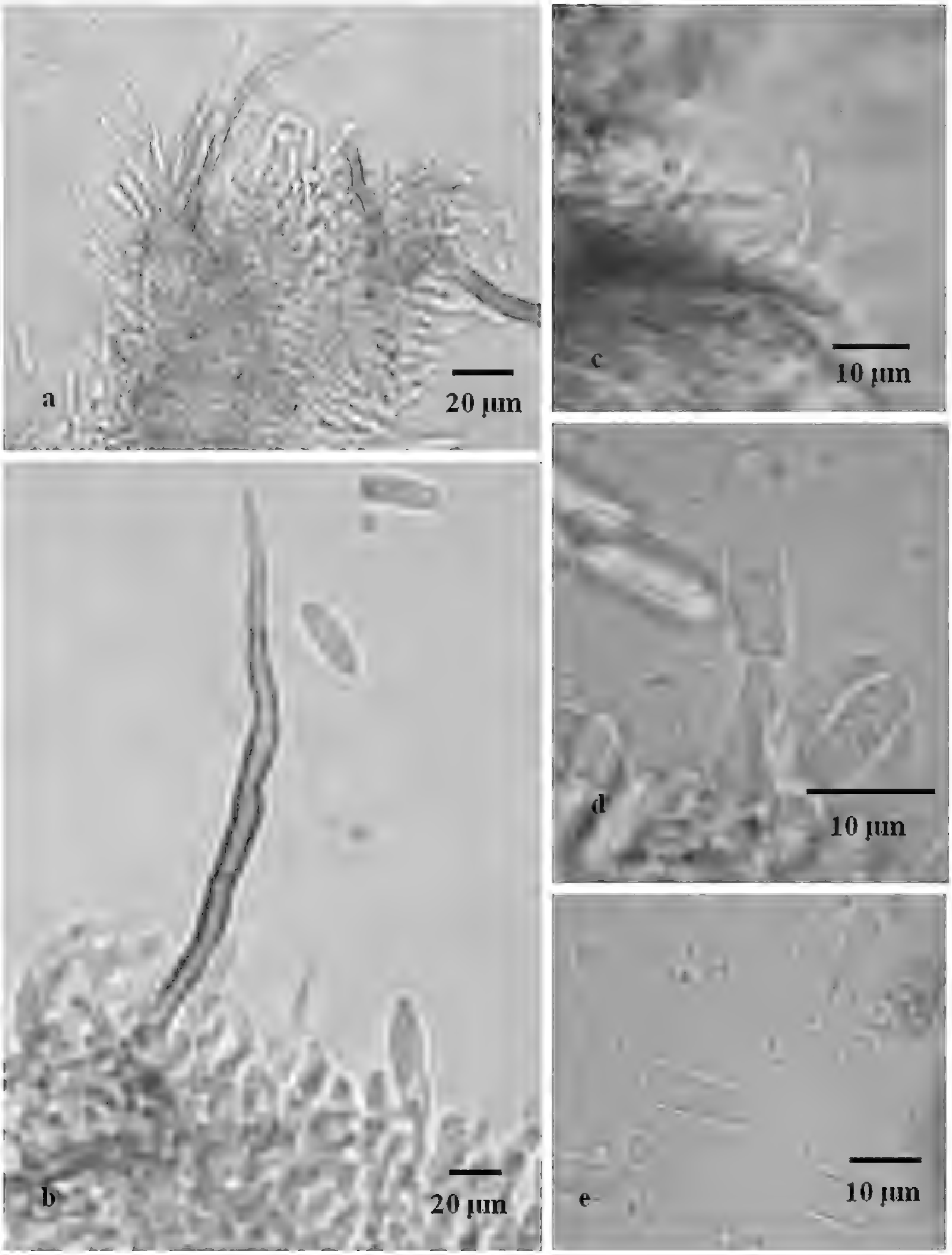


FIG. 8. *Vermiculariopsiella pteridis* a. sporodochial conidioma with setae, conidiophores and conidia; b. seta; c,d. conidiogenous cell with conidia; e. mature conidia.

10–23 (mean 17 ± 3) × 4–8.5 (mean 6 ± 1.5) µm, biseriately arranged in the asci.

ANAMORPH: CONIDIOMATA sporodochial, developing on a pseudo-parenchymatous stromatic base, scattered, 580–1115 × 400–1015 µm,

punctiform, globose, sometimes coalescing to form irregular patches, setose, with cream to peach-colored mass of conidia. SETAE numerous, smooth, unbranched, 2–5-septate, dark-brown, erect, slightly curved to flexuous, rounded to pointed apex, arising from swollen basal cells, 40–145 µm long, 1.5–3.5 µm wide in the middle, 2–6.5 µm wide at the base. CONIDIOPHORES straight, slightly curved to flexuous, smooth, septate, sparsely branched, hyaline to pale brown, 8–74 × 3–4.5 µm. CONIDIOGENOUS CELLS monophialidic, determinate, integrated or discrete, hyaline, smooth, cylindrical to lageniform, 7–40 × 3–4.5 µm, without a conspicuous collarette. CONIDIA aseptate, solitary, smooth, hyaline, oblong to cylindrical, rounded at both ends, slightly narrower and truncate at base, 10–27 (mean 17.5 ± 4.5) × 4–5.5 (mean 4.5 ± 0.5) µm.

Discussion

The genus *Echinosphaeria*, typified by *E. canescens* (Pers.) A.N. Mill. & Huhndorf, is characterized by the production of subglobose to ovoid ascomata, with unitunicate asci containing allantoid, guttulate, biseriately arranged, smooth-walled ascospores (Miller & Huhndorf 2004). The genus includes species with three different genera of anamorphs, viz. *Endophragmiella* B. Sutton, *Selenosporella*-like synanamorphs (Hughes 1979, Sivanesan 1983, Miller & Huhndorf 2004) and *Vermiculariopsiella* (Gawas et al. 2006). *Echinosphaeria pteridis* differs from the two other species in the genus (TABLE 1) — namely *E. canescens* and *E. macrospora* Gawas, Bhat and K.D. Hyde (Gawas et al. 2006) — by its larger ascocarps, longer perithecial necks, and the sizes of asci and ascospores.

The hyphomycete genus *Vermiculariopsiella*, typified by *V. immersa* (Desm.) Bender (Bender 1932), has 12 reported species (Gawas et al., 2006). The genus is characterized by the production of superficial, setose sporodochia, with simple or branched conidiophores bearing monophialidic, subcylindrical to lageniform conidiogenous cells with collarettes, producing slimy masses of hyaline, aseptate conidia (Bender 1932). Species-delineation is based on differences in size and shape of setae, conidiophores, conidiogenous cells and conidia (Gawas et al. 2006). Four species are reported from India (Keshavaprasad et al. 2003, Gawas et al. 2006).

Among the species of *Vermiculariopsiella*, *V. pteridis* is somewhat similar to *V. elegans, V. parva, V. indica* and *V. endophytica* in having unbranched setae and cylindrical conidia with rounded ends. *V. pteridis*, however, differs from *V. elegans, V. indica* and *V. endophytica* in having smaller sized conidia and from *V. parva* in sizes of conidioma and conidiogenous cell. Although identical in spore size, the type species, *V. immersa*, differs from *V. pteridis* in having recurved conidiogenous cells with a cylindrical neck and flared collarettes.

TABLE 1. Comparison of *Echinosphaeria* species

SPECIES	ASCOCARP	NECK	ASCUS	ASCOSPORES	REFERENCE
E. canescens	Subglobose to ovoid, dark brown, 500 µm diam	Inconspicuous	Cylindric-clavate, 10–12 µm diam	Uniseptate, 20–28 × 4.5 µm	Miller & Huhndorf (2004), Saccardo (1883)
E. pteridis	Pyriform, dark brown, 350–620 × 65–130 µm	Conspicuous, cylindrical; length: 145– 430 µm diameters: 100 µm (base), 50–60 µm (upper)	Clavate (rarely ovoid), 23–70 × 8–15 µm	Aseptate, 10–23 × 4–8.5 µm	Present study
E. macrospora	Pyriform, black, 410–490 × 150–265 µm	Inconspicuous	Clavate, 120–165 × 14–17.5 µm	Aseptate, 41–45 × 6–11 µm	Gawas et al. (2006)

Acknowledgments

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A new hyphomycete species from Guangxi, China

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Abstract — A new species of dematiaceous hyphomycetes is described. *Linkosia mori* is characterized by absence of conidiophores and distoseptate conidia. A new record for China, *Pleurotheciopsis websteri*, was found from the same area. The type specimens are deposited in the Herbarium of the Department of Plant Pathology, Shandong Agricultural University (HSAUP) and HMAS (Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences).

Key words — taxonomy, anamorphic fungi

Introduction

The genus *Linkosia*, which was erected by Hernández-Gutiérrez & Sutton (1997), differs from *Sporidesmium* and the other related genera by its conidiophores that are reduced to monoblastic conidiogenous cells and the conidia are solitary and distoseptate (Subramanian 1992, Hernández-Gutiérrez & Sutton 1997). *Stanjehughesia* Subram. and *Janetia* M.B. Ellis are genera related to *Linkosia* by features such as absence of conidiophores, lageniform conidiogenous cells directly formed from superficial mycelium, however, the conidia in these genera are euseptate (although *J. longispora* P.M. Kirk is distoseptate).

Worldwide, the genus *Linkosia* contains only five species, of which three have been described from China (Wu & Zhuang 2005). *Linkosia coccothrinacis* and *L. ponapensis* are reported to survive on rotten leaves while the other three previously described species occur as saprophytes on dead branches. Our study proposes a fourth, new *Linkosia* species from tropical forests also discovered on dead branches. We also note another hyphomycete species new to China.

Taxonomic description

Linkosia mori K. Zhang & X.G. Zhang, **sp. nov.** FIGURE 1
MycoBank MB 512314

* *Corresponding author*

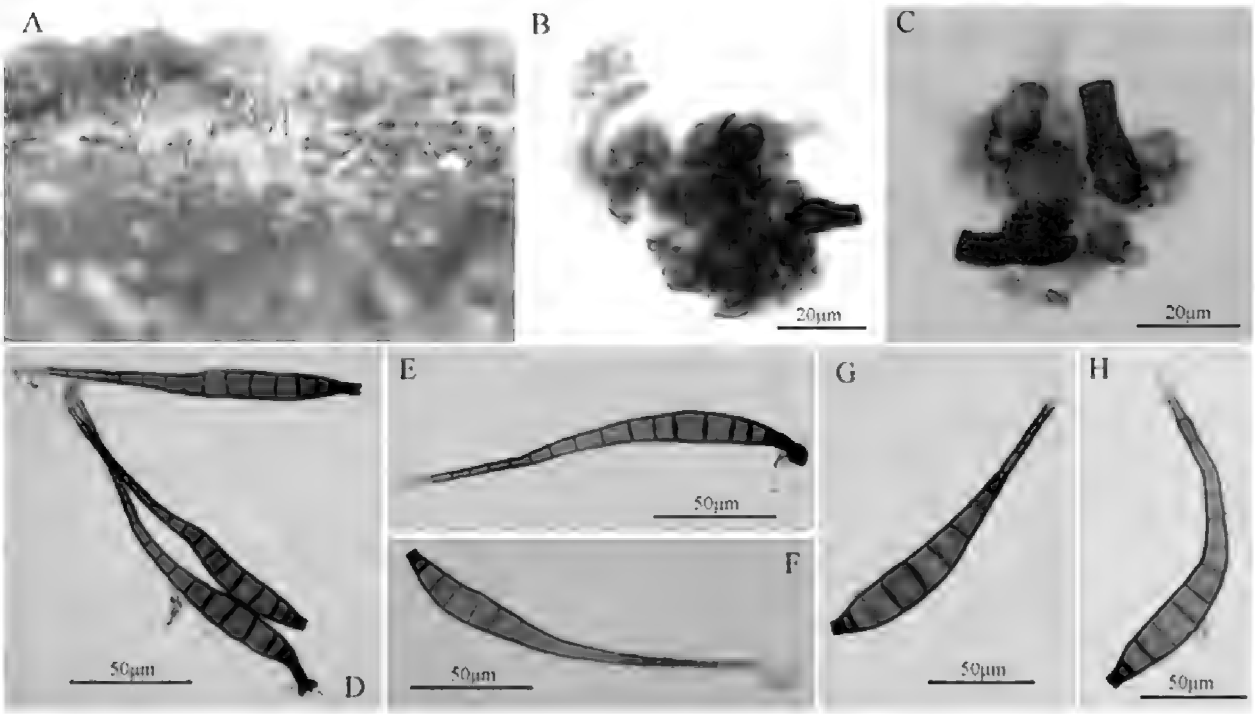

FIG. 1. *Linkosia mori*. A. Colonies on submerged wood. B–C. Conidiophore cells. D–H. Conidia and two attached conidiophores cells.

COLONIAE effusae, brunneae. Mycelium superficiale, ex hyphis ramosis, septatis, brunneis vel atrobrunneis, laevibus, 2–3.5 µm crassis compositum. CONIDIOPHORA nulla. CELLULA CONIDIOGENA monoblastica, solitaria, simplicia, lageniformia vel ampulliformia, brunnea vel atro-brunnea, laevia, 13–17 × 7–9 µm, ad apicem 4–5 µm crassa. CONIDIA holoblastica, solitaria, recta vel leviter curvata, obclavata vel obclavata-rostrata, 15–21-distoseptata, pallide brunnea vel brunnea, laevia, 122–177 × 12–16 µm; cellula apicalis subhyalina, cellula basalis cylindrica vel conico-truncata, ad basim 3.5–5.5 µm crassa.

HOLOTYPE: On dead branches of *Morus alba* L., Natural Reserve of Shiwandashan, Guangxi Province, China, May 12, 2007, Kai Zhang,HSAUPVII$_{0\text{-}ZK}$0321-2 (ISOTYPE HMAS189369)..

ETYMOLOGY: In reference to the host genus, *Morus*.

COLONIES effuse, brown. Mycelium superficial, composed of septate, brown to dark brown, smooth-walled hyphae, 2–3.5 µm thick. CONIDIOPHORES absent. CONIDIOGENOUS CELLS monoblastic, solitary, simple, lageniform or ampulliform, brown to dark brown, smooth, 13–17 × 7–9 µm, 4–5 µm wide at the truncate apex. CONIDIA holoblastic, solitary, straight or slightly curved, obclavate to obclavate-rostrate, 15–21-distoseptate, pale brown to brown, smooth, 122–177 × 12–16 µm; apical cells subhyaline, basal cell cylindrical, truncate, 3.5–5.5 µm wide.

The five species previously described in the genus include *Linkosia ponapensis* (Castañeda et al. 2000), *L. coccothrinacis* (Hernández-Gutiérrez & Sutton 1997), *L. multiseptum*, *L. fusiformis*, and *L. obclavata* (Wu & Zhuang 2005). *Linkosia mori* superficially resembles *L. obclavata* in conidial shape, but the conidia of *L. mori* are larger than those of *L. obclavata* (110–125 × 9–12 µm).

In addition, *L. obclavata* conidia have fewer septa (12–14) than those of *L. mori*. *L. mori* resembles *L. fusiformis* in conidial size, but the conidia of *L. fusiformis* are obclavate and have dark band between septa, whereas those of *L. mori* are obclavate and rostrate and lacking dark bands. A key is given to the six known taxa of *Linkosia*.

Key to described *Linkosia* species

1. Conidia with apical appendages .... *L. ponapensis*
   Conidia without apical appendages 2
2. Conidia narrowly obclavate-rostrate 3
   Conidia obclavate 4
3. Conidia with 4–7-septa, 43.5–71.5 × 7–10.5 µm .... *L. coccothrinacis*
   Conidia with 15–21-septa, 122–177 × 12–16 µm .... *L. mori*
4. Conidia with 27–30-septa .... *L. multiseptum*
   Conidia with less than 20-septa 5
5. Conidia with 15–20-septa, 100–160 × 13–15 µm .... *L. fusiformis*
   Conidia with 12–14-septa, 110–125 × 9–12 µm .... *L. obclavata*

New record from China

Pleurotheciopsis websterii Cazau, Aramb. & Cabello, 1993, Mycotaxon 46: 238.

On rotten wood of *Punica granatum* L., tropical forest of Damingshan, Guangxi province, China. May 13.2007, Kai Zhang, HSAUPVII$_{0\text{-zk}}$0424.

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Two new species of *Eladia* from soil

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Abstract — Two new species of *Eladia*, *E. inflata* and *E. minima* from soil in China, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words — anamorphic fungi, systematics

Introduction

Dale (1914: 52–53) described a fungus isolated from soil, which was tentatively regarded as a new species of *Penicillium* (as "*Penicillium* ? sp."). This collection was subsequently named as *P. sacculum* (Biourge 1923: 323; Dale 1926). Thom (1930: 538–539) made a provisional assignment of this species to *Scopulariopsis*, after studying the type material (subsequently lost). Hughes (1953: 614–615) showed that *Scopulariopsis* is not closely related to *Penicillium*, since the two genera have different methods of spore formation. *Penicillium* is enteroblastic-phialidic, while *Scopulariopsis* is holoblastic-percurrent (annellidic). Since the sporogenous cells of *P. sacculum* are phialides, Smith (1961) recombined the taxon as *Eladia saccula*, the type species of a new monotypic genus, following detailed examination of two additional collections. Matsushima (1971) described a second species, *E. striatispora*. Until now, only those two species have been reported.

During an investigation of soil fungi in Sichuan Province, two fungi were obtained from forest and mountain soil, respectively. Both match the morphological characteristics of *Eladia*, but do not resemble the other described species in this genus, and are therefore described as new species.

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Taxonomic descriptions

Eladia inflata Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 512859

Coloniae effusae, brunneo-virescens, velutinae. Mycelium et superficiale et immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1–5 μm crassis compositum. Phialophora erecta, hyalinis, simplicia vel irregulariter ramosa, septata, laevia, 9.5–65.5 μm longa, basi 2–3 μm crassa, apicem 2.5–5.5 μm crassa. Phialides hyalinae vel pallide brunneae, inflatae vel sphaericae, subsphaericae, pyriformiae, obpyriformiae, ellipsoideae, laeves, 5.5–10.5 × 2.5–7.5 μm. Conidia solitaria vel in brevicatenatis, globosa, medio-brunnea, asperula, 3–5.5 μm diametro, pro maxima parte 4 μm diametro.

Holotype: from a forest soil of Kangding County, Sichuan Province, China. Jun. 25. 2006, Y. L. Jiang, HSAUPII$_{06}$9026 (= HMAS 196210), dried culture (**holotype**), and ex-type living culture.

Etymology: in reference to the inflated phialides

Colonies effuse, brownish green, velvety. Mycelium superficial and immersed: hyphae branched, septate, hyaline, smooth, 1–5 μm thick. Phialophores erect, hyaline, simple or irregularly branched, septate, smooth, 9.5–65.5 μm long, the base 2–3 μm thick, the apex 2.5–5.5 μm thick. Phialides hyaline to pale brown, often inflating to spherical, subspherical, pyriform, obpyriform or ellipsoidal, smooth, 5.5–10.5 × 2.5–7.5 μm. Conidia solitary or forming short chains, globose, medium brown, densely spiny, 3–5.5 (commonly 4) μm diam.

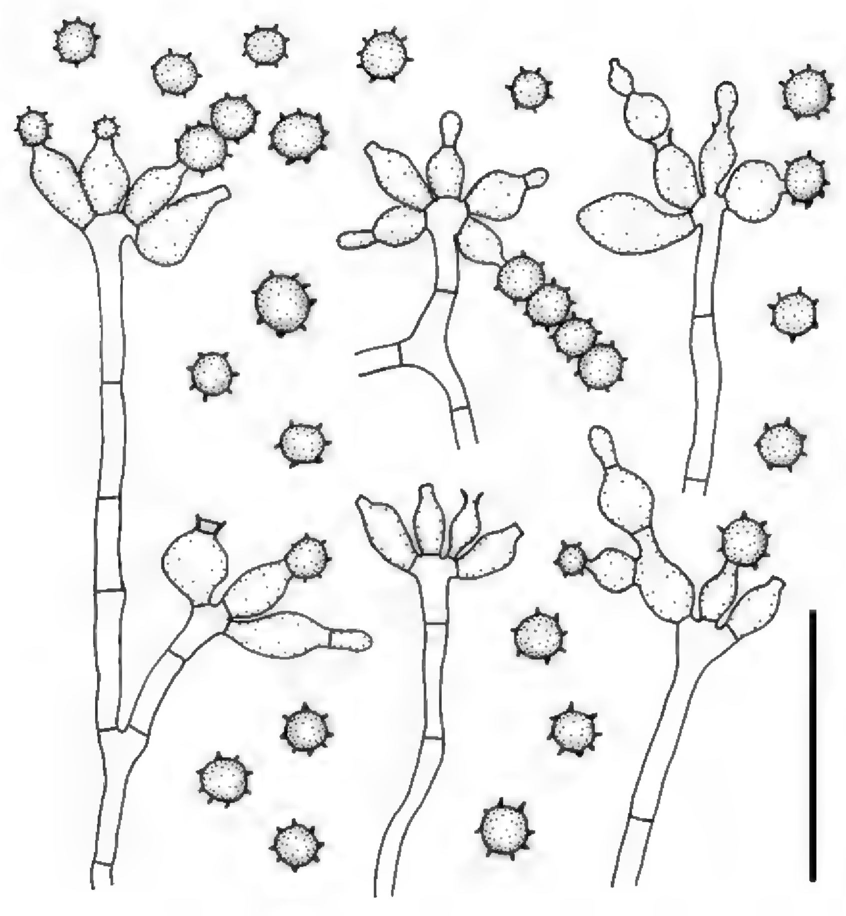

Fig. 1 Conidia and conidiophores of *Eladia inflata* (Bar=25 μm).

This new taxon differs from other described species in this genus in its larger and inflated phialides.

Eladia minima Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 2

MYCOBANK MB 512860

Coloniae effusae, griseae vel atrae, velutinae. Mycelium superficiale et immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1–3 µm crassis compositum. Phialophora erecta, hyalina, simplicia, septata, laevia, 9.5–15.5 × 1–2.5 µm. Phialides hyalinae, ovoideae vel ellipsoideae, 3–6 × 2–2.5 µm. Conidia solitaria vel in brevicatenatis, globosa, medio-brunnea, asperula, 2.5–5 µm diametro, pro maxima parte 3.5 µm diametro.

HOLOTYPE: from a mountain soil of Yajiang County, Sichuan Province, China. Jun. 26. 2006, Y. L. Jiang, HSAUPII$_{06}$9001 (= HMAS 196211), dried culture (**holotype**), and ex-type living culture.

ETYMOLOGY: in reference to the small conidia

Colonies effuse, grey to black, velvety. Mycelium superficial and immersed: hyphae branched, septate, hyaline, smooth, 1–3 µm thick. Phialophores erect, hyaline, simple, septate, smooth, 9.5–15.5 × 1–2.5 µm. Phialides hyaline, ovate or ellipsoidal, 3–6 × 2–2.5 µm. Conidia solitary or forming short chains, globose, medium brown, densely spiny, 2.5–5 (commonly 3.5) µm diam.

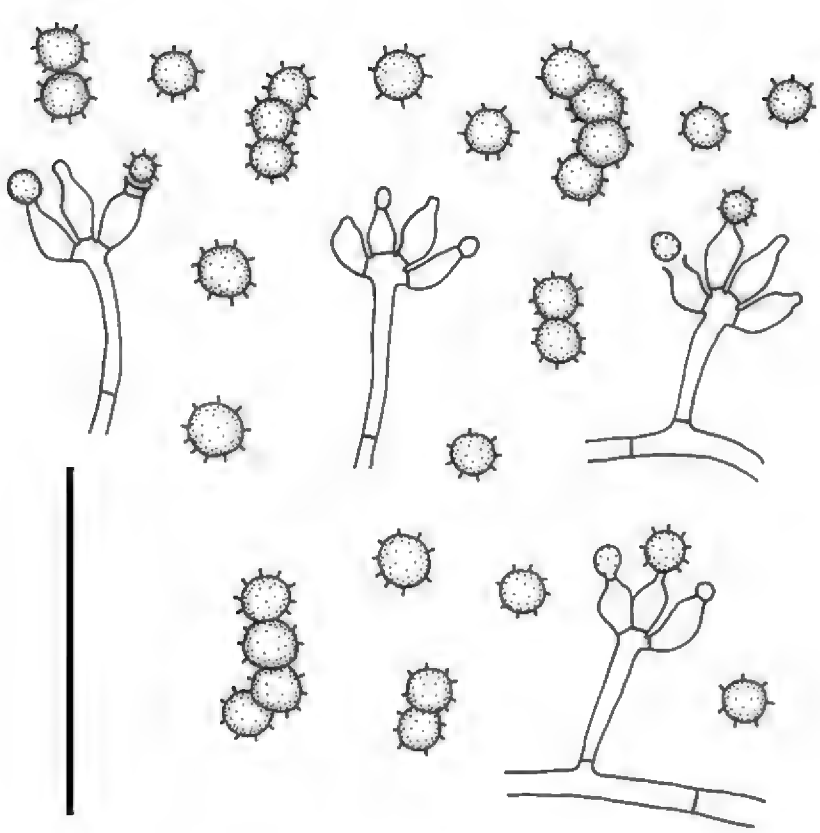

FIG. 2 Conidia and conidiophores of *Eladia minima* (Bar=25 µm).

E. minima resembles *E. saccula* (Smith 1961), but the latter having bigger conidia (5–6 µm diam.) and phialides (5.5–6 × 3–3.5 µm). The following key shows how the four species of *Eladia* differ.

Key to the species of *Eladia* G. Sm.

1. Phialospores with 6–9 longitudinal striations .... *E. striatispora*
   Phialospores without longitudinal striations 2
2. Phialides often quite inflated to spherical, subspherical, or obpyriform...... *E. inflata*
   Phialides often ovoid or ellipsoidal, rarely spherical, subspherical, or obpyriform ... 3
3. Phialospores 2.5–5 (commonly 3.5) µm diam, phialides 3–6 × 2–2.5 µm .. *E. minima*
   Phialospores 5–6 µm diam, phialides 5.5–6 × 3–3.5 µm .... *E. saccula*

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Phacellium brachybotrydis sp. nov. on *Brachybotrys paridiformis*

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Abstract — *Phacellium brachybotrydis* sp. nov., causing leaf discolorations of *Brachybotrys paridiformis*, was collected in Korea. The new fungus is described, illustrated, and compared with *Cercospora subhyalina*, recorded on the same host, as well as two morphologically similar *Phacellium* species, *P. gracilipes* and *P. dearnessii*.

Key words — cercosporoid fungus, *Mycosphaerellaceae*, taxonomy

Introduction

In the course of field surveys of phytopathogenic fungi carried out after the publication of a comprehensive taxonomic studies on *Cercospora* and the allied genera in Korea (Shin & Kim 2001), a cercosporoid hyphomycete associated with discolored lesions of *Brachybotrys paridiformis* was found. It is well-characterized by synnemata pigmented only at the base, colorless conidiogenous cells and conidia, and terminal to rarely pleurogenous conidiogenous cells. These features agree well with Braun's (1998) concept of *Phacellium* Bonord. The fungus is described, illustrated, and compared with related cercosporoid fungi.

Materials and methods

Fresh collections or herbarium specimens were used for morphological observations. A small piece of living tissue containing fungal structures was mounted in a drop of water for microscopic examinations. The dried specimens were rehydrated in 3% KOH solution and then observed. Measurement of conidiophores and conidia for each sample was made from 40–50 replicates at

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magnification of 400× and 1000× with an eye-piece micrometer under a light microscope (Olympus BX51), and images were photographed using a Zeiss Axio imager microscope. All dried specimens are housed in the herbarium KUS of the Korea University, Seoul, Korea.

Taxonomy

Phacellium brachybotrydis M.J. Park & H.D. Shin, **sp. nov.** Fig. 1–2

MycoBank MB512913

Maculae inconspicuae, diffusae, flavidae vel olivaceae, margine indefinito. Conidiomata hypophylla, synnematalia, solitaria, primo pallida vel albida deinde rubella. Mycelium immersum; hyphae septatae, ramosae, hyalinae vel dilutissime olivaceae. Synnemata erecta, ex stromatibus substomatalibus oriunda, 90–200 × 15–40 µm, primo laxa, deinde aggregata, subcylindrica, ad basim rubro-brunnea vel brunnea, apicem versus pallidiora, interdum omnino pigmentosa; conidiophora 2–3 µm lata, septata, simplicia, laevia; cellulae conidiogenae terminales vel raro pleurogenae, subrectae vel interdum sinuosae, apice geniculato, hyalinae; cicatrices conidiales conspicuae, parvae, incrassatae, fuscae. Conidia catenata vel ramicatenata, cylindrica vel ellipsoidea, recta, hyalina, aseptata, interdum uniseptata, ad septum non constricta, verruculosa, utrimque obtusa vel subobtusa, 10–35 × 3–5 µm; hila incrassata, fuscata, non eminentia.

Etymology – The epithet refers to the genus name of the host.

Holotype – On living leaves of *Brachybotrys paridiformis* Maxim. (*Boraginaceae*), Korea, Chuncheon, 4 September 2008, M.J. Park & H.D. Shin (*KUS-F23641*).

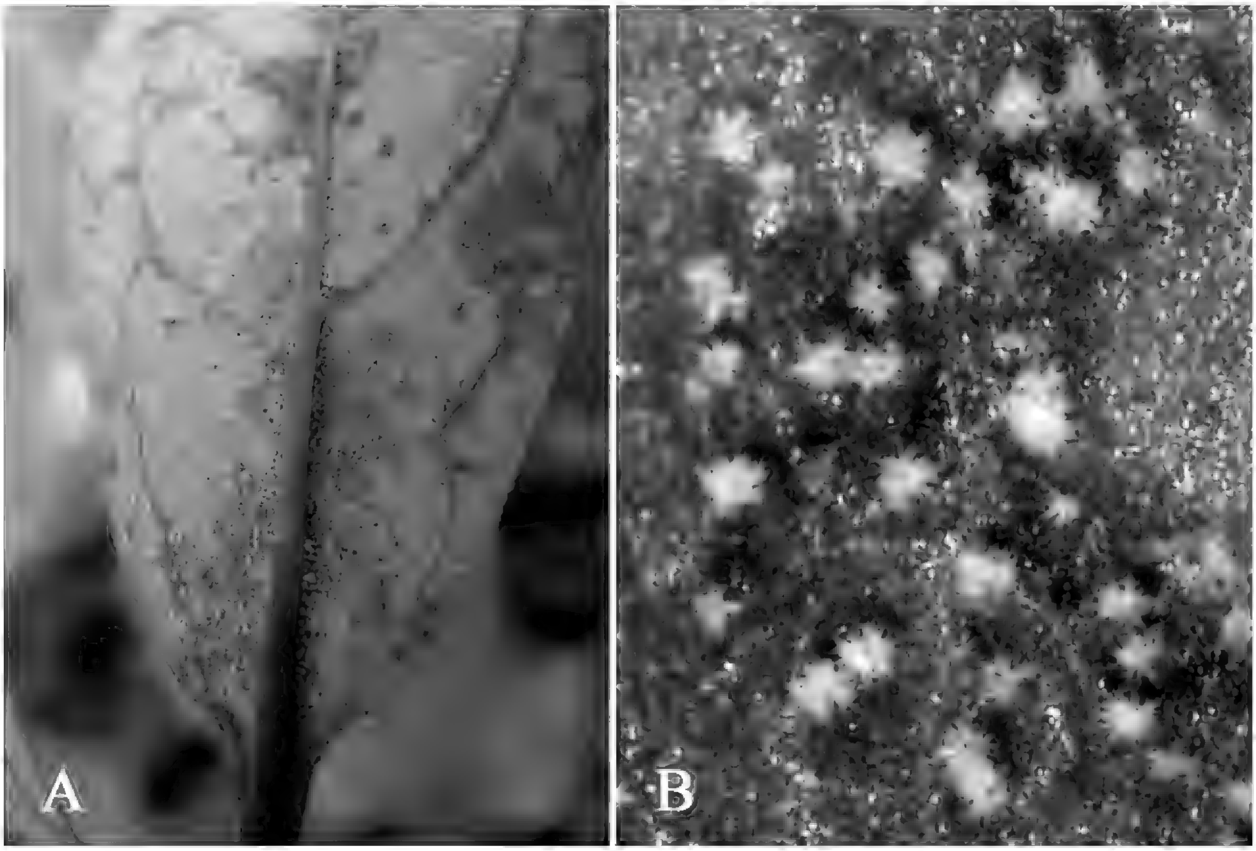

Fig. 1. A - The lower leaf surface of *Brachybotrys paridiformis* infected with *Phacellium brachybotrydis*. B - Close-up of leaf lesion.

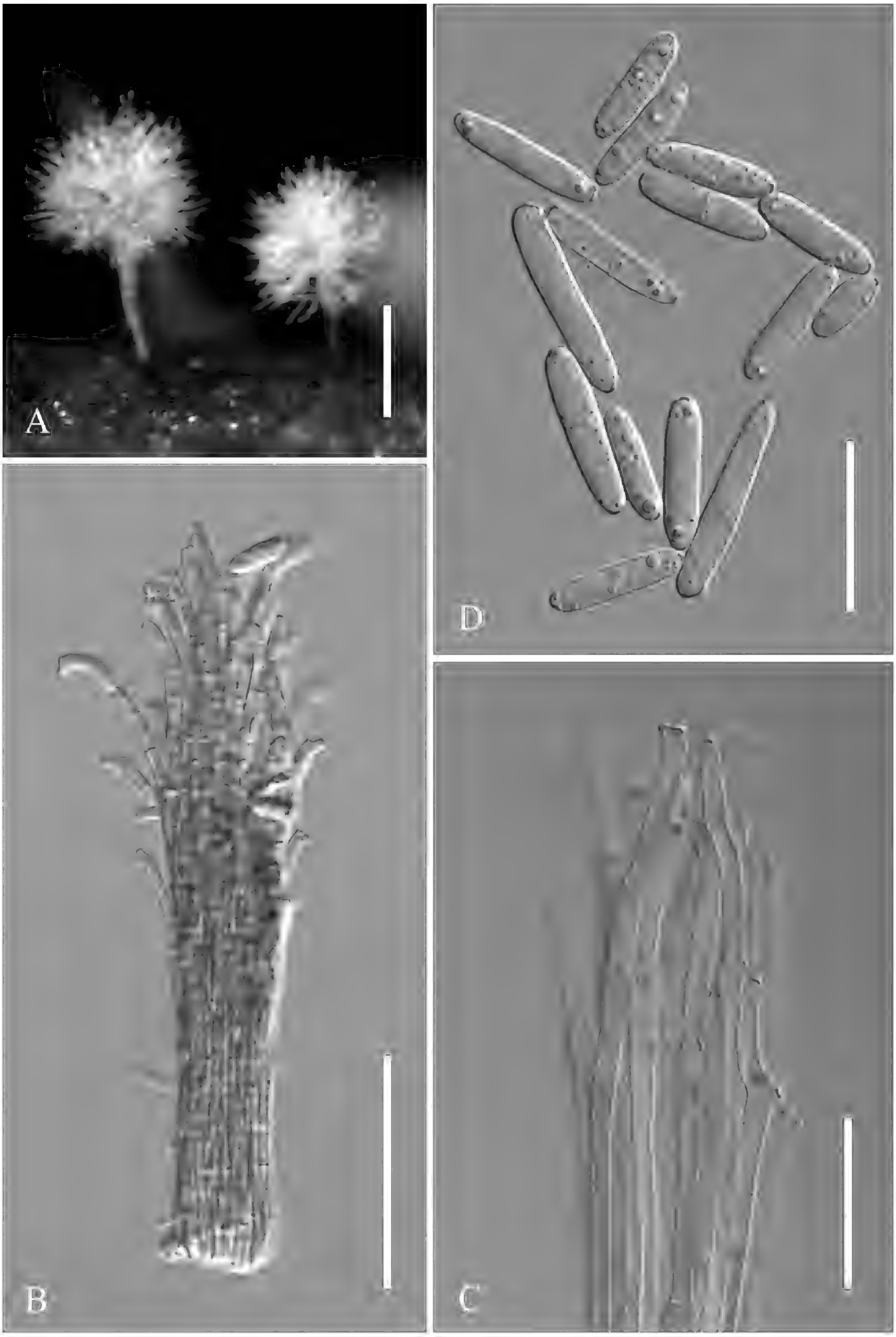

FIG. 2. *Phacellium brachybotrydis*: A - Tree-like synnemata; B - synnemata; C - Upper portion of conidiophores; D - Conidia. Scale bar: A = 100 μm, B = 50 μm, C & D = 20 μm.

Leaf spots inconspicuous, diffuse, yellowish to olivaceous discolorations, margin indefinite. Conidiomata hypophyllous, synnematous, solitary, at first pale to whitish, later pink. Mycelium internal; hyphae septate, branched, hyaline to faintly pigmented. Synnemata erect, arising from substomatal stromata, 90–200 × 15–40 µm, at first rather loose, but later densely aggregated, forming firm stalks, subcylindrical, composed of numerous compact parallel conidiophores, apically splaying out, reddish brown to brown at the base, paler towards the apex, sometimes pigmented almost throughout; individual conidiophores 2–3 µm wide, septate, simple, smooth; conidiogenous cells terminal as well as rarely pleurogenous, almost straight to partly sinuous, geniculate at the apex, hyaline or almost so; conidial scars conspicuous, small, thickened and darkened. Conidia catenate, sometimes in short branched chains, cylindrical to ellipsoidal, straight, hyaline, usually aseptate but occasionally uniseptae, non-constricted at the septa, verruculose, obtuse to subobtuse at both ends, 10–35 × 3–5 µm; hilum slightly thickened, darkened, and non-protuberant.

Additional Specimens Examined – Korea, Chuncheon, 24 August 2004, H.D. Shin (*KUS-F20648*); Korea, Hoengseong, 19 October 2008, M.J. Park & H.D. Shin (*KUS-F23853*).

Notes – Recently, as stated by Braun & Crous (2008), the taxonomic position of *Phacellium* within cercosporoid anamorphs of *Mycosphaerella* Johanson is not yet clearly confirmed. Thus, the genus concept of *Phacellium* as circumscribed by Braun (1998) is currently maintained and followed in the present study. Further studies on a molecular basis encompassing more isolates are needed to evaluate the taxonomic status and phylogenetic relationship of the genus *Phacellium* within anamorph genera of *Mycosphaerella*.

Only a single cercosporoid species, *Cercospora subhyalina* H.D. Shin & U. Braun (Braun 1995) was described on *Brachybotrys paridiformis* from Korea. It is clearly distinguished from the present fungus by having short, hyaline to subhyaline conidiophores (20–50 × 2–5 µm) and scolecosporous conidia (30–50 × 1.5–4.5 µm).

There is no comparable species possessing synnematous conidiophores found on species of the genus *Brachybotrys* or other genera in the *Boraginaceae*, as found in *Phacellium* and the allied genus *Tandonella* S.S. Prasad & R.A.B. Verma. Based on the morphology of conidia and conidiophores, the new fungus resembles two other *Phacellium* species — *P. gracilipes* (Davis) U. Braun on a host of the *Cornaceae* (Braun 1994) and *P. dearnessii* (Bubák) U. Braun on a host of the *Myricaceae* (Braun 1992). The new species on *Brachybotrys paridiformis* is characterized by verruculose conidia with obtuse ends and reddish brown synnemata. *Phacellium gracilipes* differs from *P. brachybotrydis* in having slightly longer (15–40 µm), almost smooth to verruculose conidia and

yellowish to pale brownish synnemata. *Phacellium dearnessii* is distinguished from *P. brachybotrydis* by its smooth to verruculose conidia with somewhat pointed ends and subhyaline to yellowish synnemata. In addition, compared to the conspicuous necrotic leaf spots produced by *P. gracilipes* and *P. dearnessii,* the new fungus forms inconspicuous leaf lesions appearing as yellowish to olivaceous discolorations. These differences support *P. brachybotrydis* as representing a new, undescribed *Phacellium* species on a host of the *Boraginaceae.*

Acknowledgments

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MYCOTAXON

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New records of *Puccinia* and *Pucciniastrum* from Pakistan

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Abstract — Six species of rust fungi from northwestern Pakistan are described. Among these, *Puccinia bolleyana, P. pygmaea* var. *pygmaea,* and *Pucciniastrum areolatum* are new records for Pakistan.

Key words — North-West Frontier Province, *Pucciniales, Pyrus pashia*

Introduction

During rust surveys in Pakistan, six species of rust fungi were found and collected on different host plants in the northwestern region. Among these, three rust taxa — *Puccinia bolleyana* on *Carex flacca*, *P. pygmaea* var. *pygmaea* on *Agrostis gigantea* and *Pucciniastrum areolatum* on *Pyrus pashia* — are new additions to the rust flora of Pakistan. *Leersia oryzoides* is a new host for *Puccinia striiformis* var. *striiformis* in Pakistan. *Puccinia cynodontis* and *Puccinia pilearum* have previously been reported from Pakistan, but here they are reported from the North-West Frontier Province for the first time and their descriptions are updated.

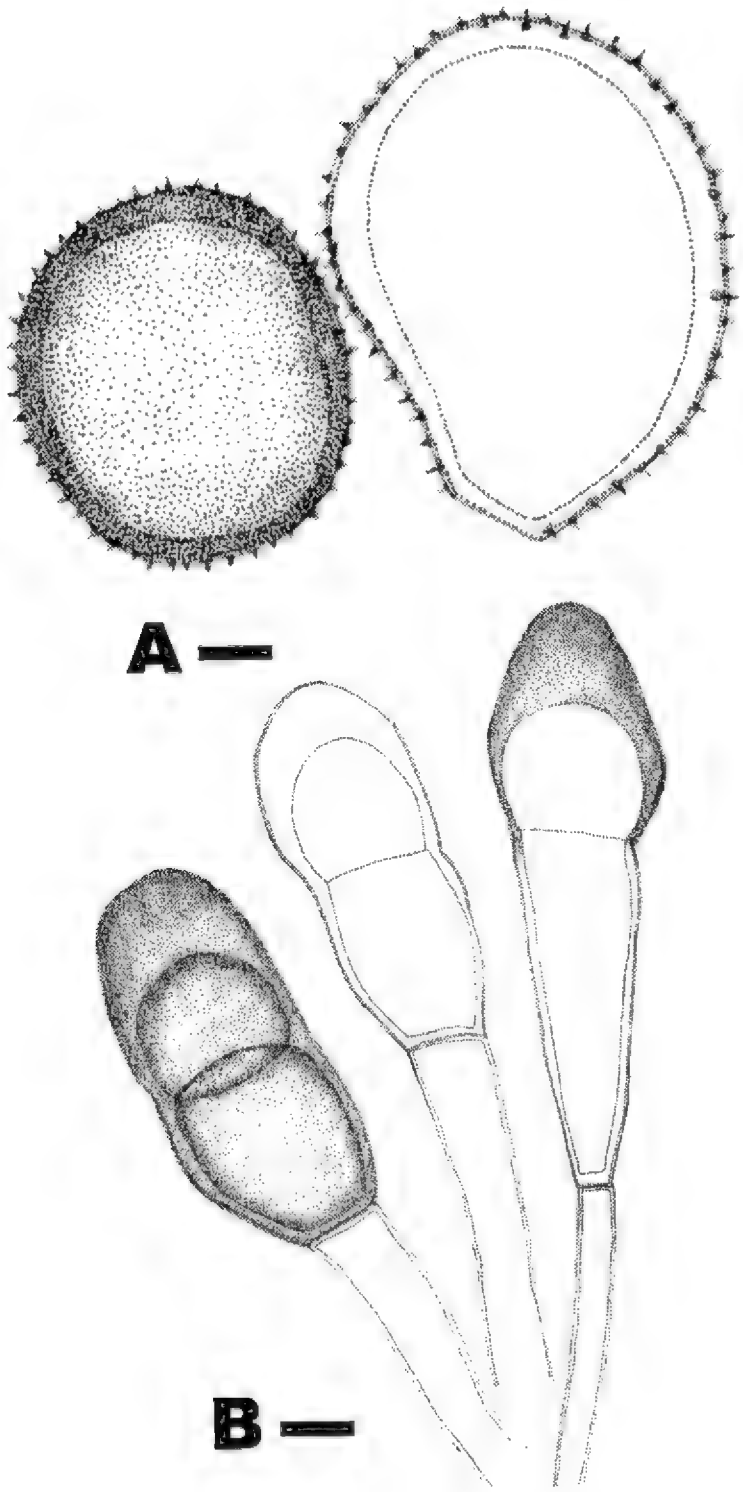
Materials and methods

Specimens were collected from different areas of Pakistan. Freehand sections of infected tissues and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed and a Scanning Electron Microscope. Drawings were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken with an ocular micrometer. At least 25 spores were measured for each spore stage. The rusted specimens have been deposited in the Herbarium of Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia bolleyana Sacc., Syll. fung. (Abellini) 9: 303 (1891) (FIGS. A–B)

SPERMOGONIA and AECIA unknown. UREDINIA mostly hypophyllous, sometimes amphigenous, on leaves and culms, intermixed with telia. UREDINIOSPORES ovoid to ellipsoid, (15–)18–24 × 23–32 µm (mean 20.4 × 26.5 µm); wall 2–3 µm thick, pale brown to cinnamon brown, finely echinulate; germ pores 2,



FIGS. A–B. Drawings of *Puccinia bolleyana*.
A. Mature urediniospores showing germ pores (scale bar = 6 µm).
B. Mature teliospores (scale bar = 12 µm).

equatorial, pedicel hyaline, 5–7 × 20–25 μm. Telia mostly hypophyllous, rarely amphigenous, intermixed with uredinia, dark brown to blackish brown, covered by the epidermis, 0.2–0.4 × 0.2–0.5 mm. Teliospores clavate to oblong, constricted at the septum, rounded above, narrowed below, 21–24 × (28–)40–59 μm (mean 22.74 × 47.53 μm); wall 2–3 μm thick, chestnut brown to golden brown, smooth; apex mostly rounded, 6–10 μm thick; germ pores obscure; pedicel persistent, cylindrical, hyaline to light brown, thin walled, 7–10 μm wide and up to 70 μm long.

Material examined: On *Carex flacca* Schreb., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 16t September 2007, NSA # 16096 [II, III], (LAH Herbarium No. NSA 1033).

The rust fungi already reported on *Carex* spp. from Pakistan include *Puccinia caricina* DC. and *P. caricis-filicinae* Barclay on *Carex filicina* Nees; *P. dioicae* Magnus and *P. pakistani* S. Ahmad on *Carex nubigena* D. Don. ex Tilloch & Taylor (Ahmad et al. 1997). *Puccinia bolleyana* is a new record for Pakistan.

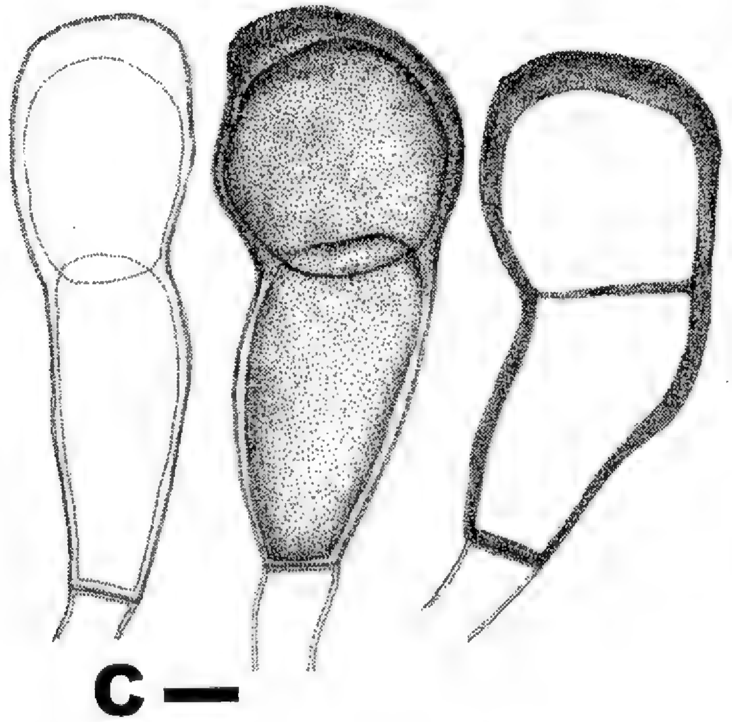


Fig. C. Lucida drawing of teliospores of *Puccinia pygmaea* var. *pygmaea* (scale bar = 9 μm).

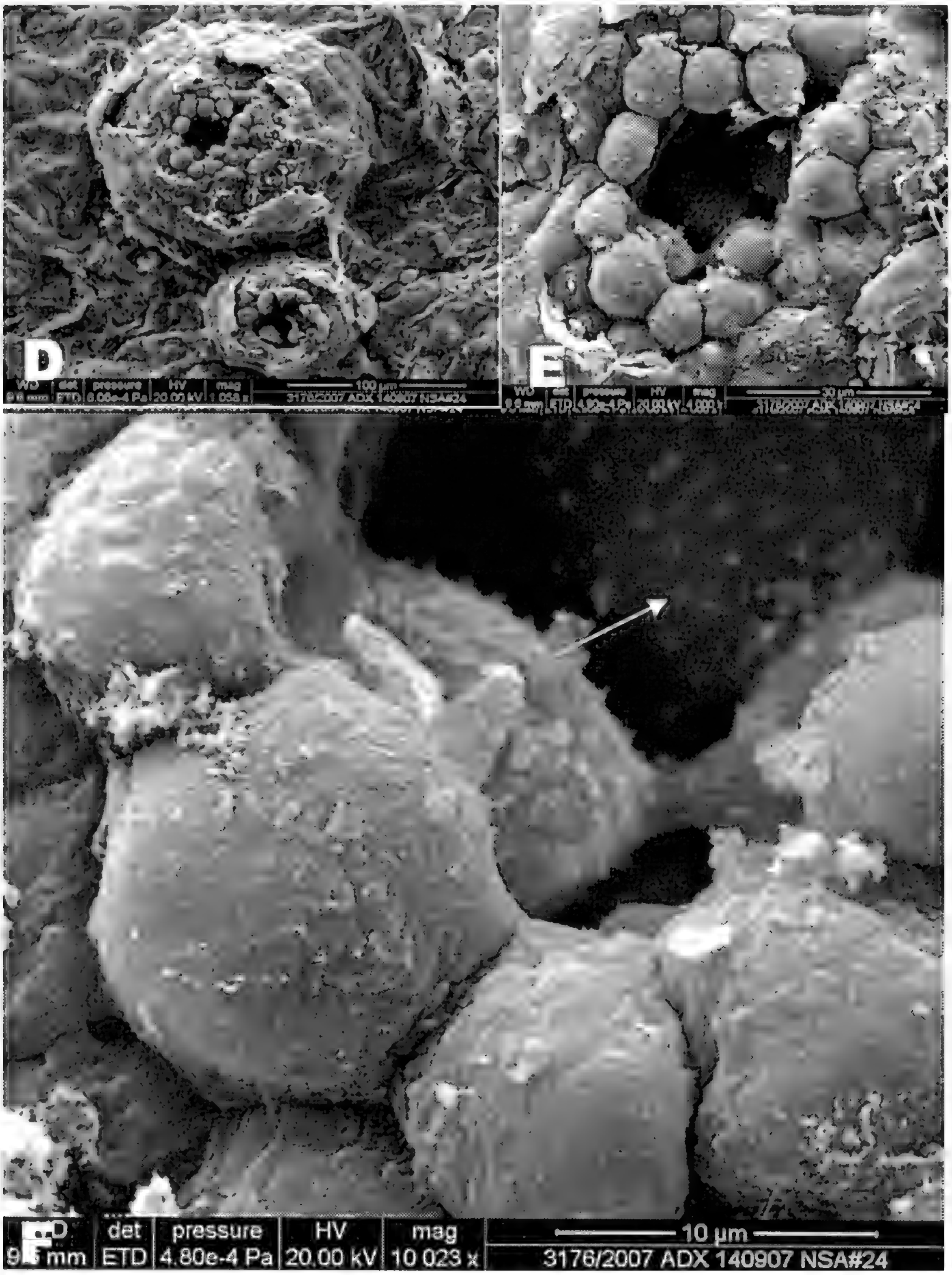
Puccinia pygmaea Erikss., Fungi paras. scand: no. 449 (1895) **var. *pygmaea***

(Fig. C)

Spermogonia, aecia and uredinia not found. Telia amphigenous, covered by the epidermis, dark brown to blackish brown, loculate, 0.09–0.5 × 0.2–0.8 mm. Teliospores 1–2-celled by transversal septum, clavate or ellipsoid; wall 1.5–2 μm thick, pale brown to chestnut brown, smooth; 13–20 × 38–56 μm (mean 16.62 × 47.54 μm); apex mostly truncate, sometimes rounded to conical,

3–6 µm thick; germ pore 1 per cell, obscure; pedicel hyaline to light brown, 5–7 × 6–12 µm, one-celled spores rare.

Material examined: On *Agrostis gigantea* Roth, Pakistan, North-West Frontier Province (NWFP), Bara Gali, at 2407 m a. s. l., 12t October 2007. , NSA # B13 [II], (LAH Herbarium No. NSA 1084).



Figs. D–F. *Pucciniastrum areolatum*. D–E. SEM photographs of subepidermal uredinial sori containing peridial cells and urediniospores F. Urediniospores (shown by arrow) surrounded by peridial cells.

Puccinia pygmaea has been reported on *Agrostis munroana* Aitch. & Hemsl. from Kaghan valley by Ahmad (1956a, b).

Six varieties of *P. pygmaea* have been recognized on the basis of spore sizes, viz. *P. pygmaea* var. *ammophilina* (Mains) Cummins & H.C. Greene, *P. pygmaea* var. *chisosana* Cummins, *P. pygmaea* var. *pygmaea*, *P. pygmaea* var. *minor* Cummins & H.C. Greene, *P. pygmaea* var. *angusta* Cummins & H.C. Greene, and *P. pygmaea* var. *major* Cummins & H.C. Greene (Cummins 1971). *Puccinia pygmaea* var. *pygmaea* is a new record for Pakistan.

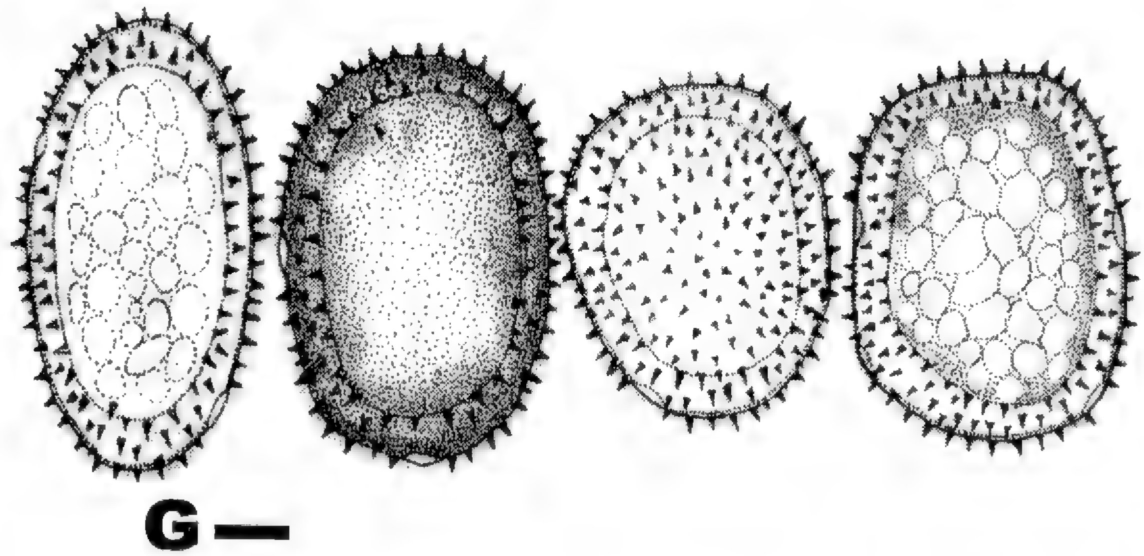


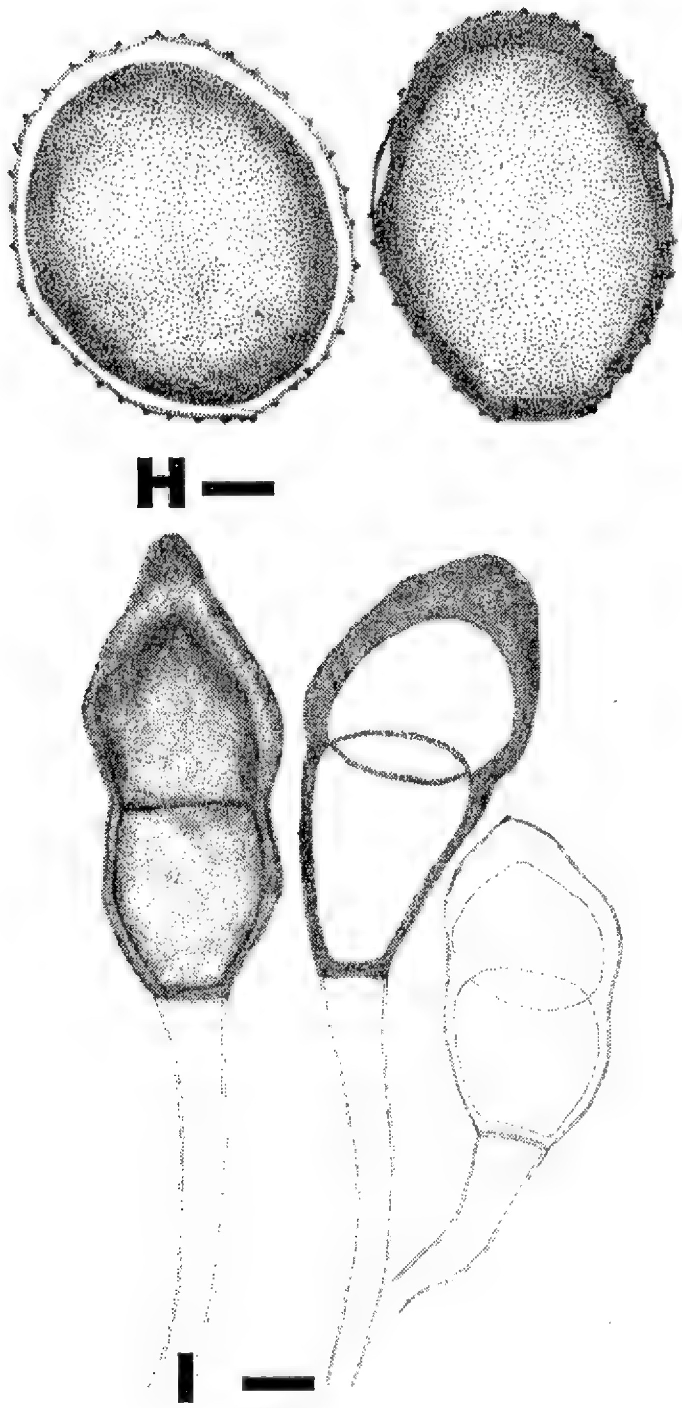
Fig. G. Mature urediniospores of *Pucciniastrum areolatum.* Scale bar = 10 μm.

Pucciniastrum areolatum (Fr.) G.H. Otth, Mitt. naturf. Ges. Bern 1863: 85 (1864) (Figs. D–G)

Spermogonia, aecia and telia not found. Uredinia hypophyllous, 0.07–0.1 × 0.08–0.2 mm, light yellow to light brown, subepidermal, minute, crowded, in small groups, covered by a hemispherical peridium, opening by a pore. Peridial cells minute, cubicle to irregular, thin walled, hyaline to light yellow, smooth, ostiolar cells irregular in shape. Urediniospores sub-globose or ellipsoid to broadly ellipsoid, 14–20 × 15–26 μm; wall 1–1.5 μm thick, hyaline to light yellow, echinulate; germ pores 2–5, scattered, obscure; pedicel deciduous, cylindrical, hyaline, minute, fragile. Paraphyses not seen.

Material examined: On *Pyrus pashia* Buch.-Ham. ex D. Don, Pakistan, Northern Areas, Gilgit, at 2575 m a. s. l., 21s August 2007, NSA # 36 [II], (LAH Herbarium No. NSA 1103).

Pucciniastrum areolatum is a new record for Pakistan. No rust fungus has been previously reported on *Pyrus* from Pakistan.



Figs. H–I. *Puccinia cynodontis.*
H. Finely verrucose urediniospores (scale bar = 10 μm).
I. Mature teliospores (scale bar = 12 μm).

Puccinia cynodontis Lacroix, in Desmazières, Pl. Crypt. France, 2e Éd., 2e Sér.: no. 655 (1859) (Figs. H–I)

Spermogonia and aecia unknown. Uredinia amphigenous, mostly on abaxial surface, subepidermal, yellowish brown to cinnamon brown, 0.09–0.1 × 0.1–2.0 mm. Urediniospores globose to subglobose, 19–27(–30) × (21–)23–33 μm (mean 25.04 × 27.98 μm); wall 2–3 μm thick, pale brown to cinnamon brown, finely verrucose; germ pores 2–3, equatorial, pedicel persistent, cylindrical, hyaline, short. Telia mostly abaxial, sometimes amphigenous, early exposed,

dark brown to blackish brown, 0.2–0.4 × 0.2–0.6 mm. TELIOSPORES two-celled by transverse septum, clavate to ellipsoid, 18–28 × (28–)37–45(–58) µm (mean 23.30 × 43.26 µm); wall 2–3µm thick, chestnut brown to golden brown, smooth; apex mostly acuminate, 6–10 µm thick; germ pores obscure; pedicel persistent, cylindrical, hyaline to light brown, thin walled, 10–12 × 60–70 µm.

MATERIAL EXAMINED: On *Cynodon dactylon* (L.) Pers., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 29^{t} July 2006. NSA # 71 [II, III], (LAH Herbarium No. NSA 1051).

Puccinia cynodontis has been reported on *Cynodon dactylon* from Tandojam, Karachi, Faisalabad and Quetta by Sydow and Ahmad (1939), Ahmad (1956a, b), Hasnain et al. (1959), Khan and Kamal (1968), Ghaffar and Kafi (1968), Malik et al. (1968) and Malik & Virk (1968). It is herein reported for the first time from north-west Pakistan.

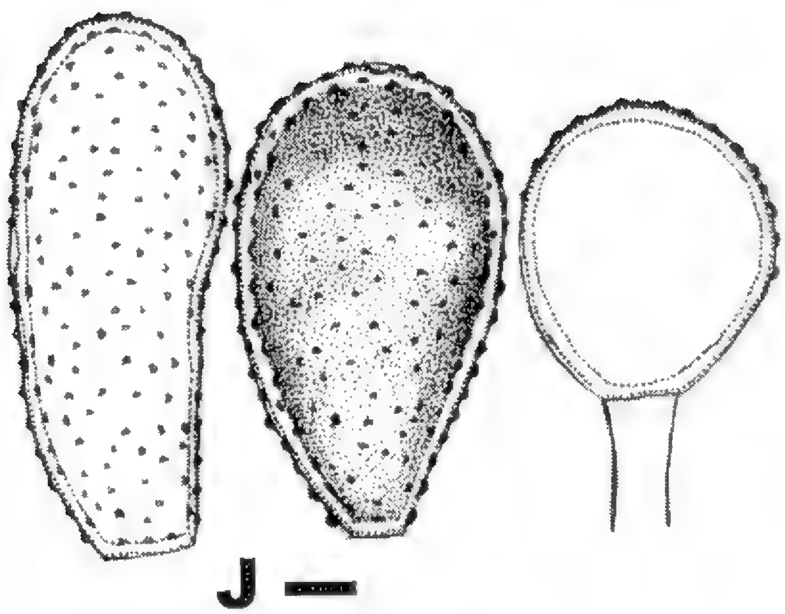


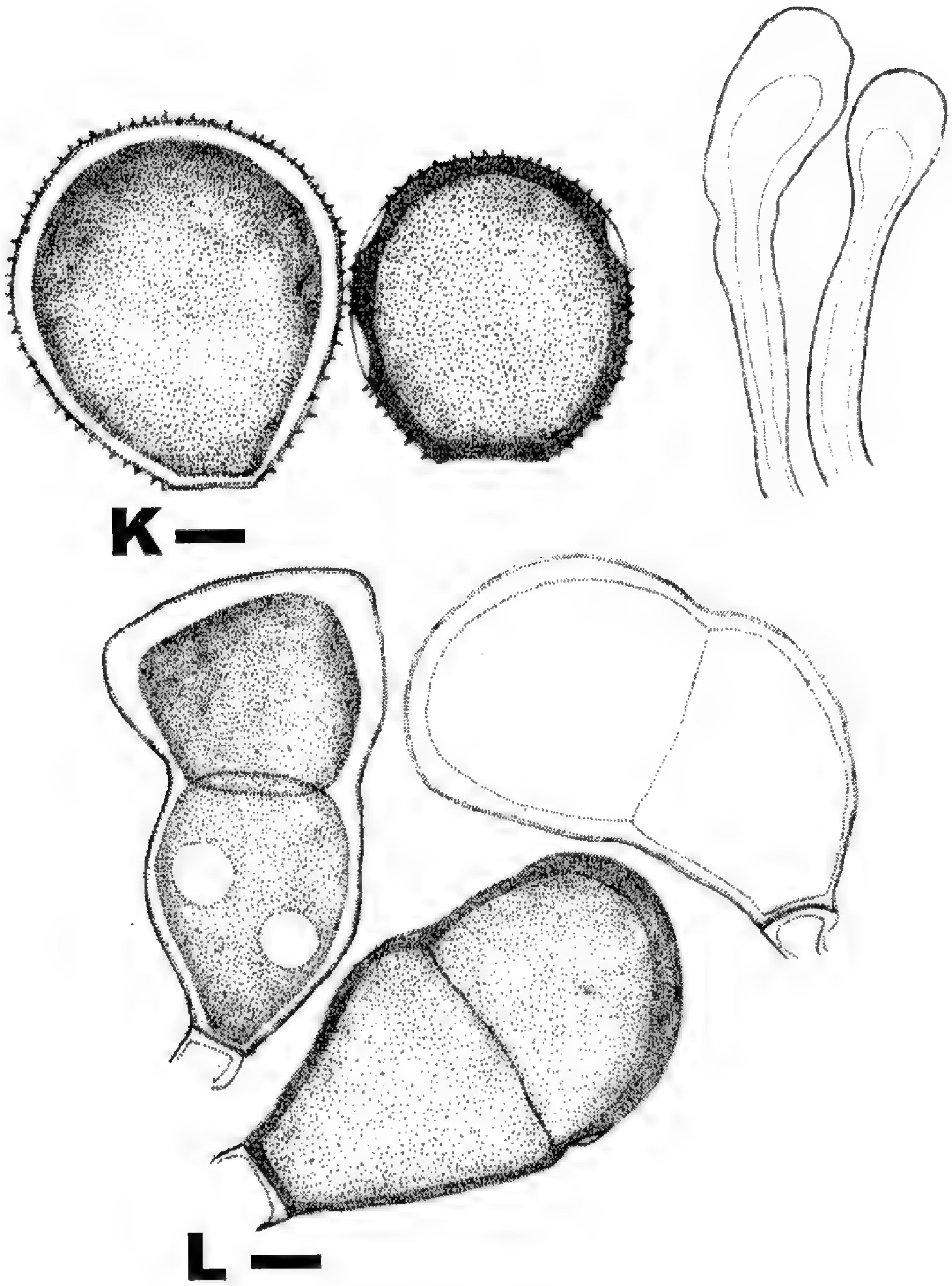
FIG. J. Mature urediniospores of *Puccinia pilearum*. (scale bar = 8 µm).

Puccinia pilearum Durrieu, Mycotaxon 9(2): 488 (1979) (FIG. J)

SPERMOGONIA and AECIA unknown. UREDINIA epiphyllous, scattered over the whole leaf surface, 0.07–0.1 × 0.1–0.3 mm, pale brown, covered by the epidermis. UREDINIOSPORES sub-globose or ellipsoid to broadly ovoid, 13–18 × 17–32 µm; wall 1.4–2 µm thick, hyaline to pale yellow, verrucose; germ pores scattered, very obscure; deciduous, cylindrical pedicel hyaline, short, up to 15 µm long.

MATERIAL EXAMINED: On *Pilea umbrosa* Wedd., Pakistan, North-West Frontier Province (NWFP), Khanspur, at 2575 m a. s. l., 21^{s} August 2005. NSA # 33 [II], (LAH Herbarium No. NSA 1076).

Puccinia pilearum has been reported on *Pilea umbrosa* from Kaghan valley, Sharan and north of Kawai by Ono (1992) and Ono & Kakishima (1992). It is new record for Khanspur (NWFP).



FIGS. K–L: *Puccinia striiformis* var. *striiformis*.
K. Urediniospores and paraphyses. L. Teliospores.
(scale bar for K & L = 10 µm).

Puccinia striiformis Westend., Bull. Acad. Roy. Sci. Belgique 21: 235 (1854)
var. ***striiformis*** (FIGS. K–L)

SPERMOGONIA and AECIA unknown. UREDINIA mostly on the adaxial surface, sometimes amphigenous, yellow to yellowish orange, 0.05–0.06 × 0.2–0.3 mm. UREDINIOSPORES ellipsoid-broadly ellipsoid or broadly obovoid, hyaline to pale yellow, closely echinulate, 16–24 × 23–33 µm; wall 1.5–2 µm thick; germ pores 10–12, scattered, obscure. Pedicel deciduous, short. PARAPHYSES intermixed, abundant, hyaline, cylindric to capitate, apex 17–20 µm thick, 6–8 µm wide

at the base and up to 90 µm long. Telia amphigenous or mostly abaxial, black, striate, covered by the epidermis, loculate, 0.09–0.15 × 0.03–0.04 mm, surrounded by a few paraphyses. Teliospores 2-celled by transversal septum, but one-celled teliospores are also common, mostly oblong-clavate or variable, 18–26 × 35–58 µm, pale golden to chestnut brown, often paler basally; wall 1.5–2 µm thick at the sides, 3–6 µm thick apically, apex truncate, rounded or conical, not or slightly constricted at septa, base attenuated; pedicel short, 6–8 × 6–17 µm.

Material examined: On *Leersia oryzoides* (L.) Sw., Pakistan, North-West Frontier Province (NWFP), Khanspur-Ayubia, at 2575 m a. s. l., 20th September 2006. NSA # 85 [II, III], (LAH Herbarium No. NSA 1091).

Puccinia striiformis has been reported on *Triticum aestivum* L., *Hordeum vulgare* L. and *Poa* sp. from Quetta, Kalat, Tandojam, Rawalpindi, Nathia Gali (NWFP), Shogran (Kaghan valley), Lahore by Ahmad (1956a, b), Khan & Kamal (1968), Malik et al. (1968), Malik & Virk (1968) and Kakishima et al. (1993b). *Leersia oryzoides* is a new host for this rust species in Pakistan.

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Geomyces destructans sp. nov. associated with bat white-nose syndrome

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Abstract — We describe and illustrate the new species *Geomyces destructans*. Bats infected with this fungus present with powdery conidia and hyphae on their muzzles, wing membranes, and/or pinnae, leading to description of the accompanying disease as white-nose syndrome, a cause of widespread mortality among hibernating bats in the northeastern US. Based on rRNA gene sequence (ITS and SSU) characters the fungus is placed in the genus *Geomyces*, yet its distinctive asymmetrically curved conidia are unlike those of any described *Geomyces* species.

Key words — *Ascomycota, Helotiales, Pseudogymnoascus,* psychrophilic, systematics

Introduction

Bat white-nose syndrome (WNS) was first documented in a photograph taken at Howes Cave, 52 km west of Albany, NY USA during winter, 2006 (Blehert et al. 2009). As of March 2009, WNS has been confirmed by gross and histologic examination of bats at caves and mines in Massachusetts, New Jersey, Vermont, West Virginia, New Hampshire, Connecticut, Virginia, and Pennsylvania. The

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syndrome is characterized by the presence of profuse yet delicate hyphae and conidia on bat muzzles, wing membranes, and/or pinnae, although these surface signs are readily removed. Histological examination of infected bats shows that fungal hyphae pervade the bat tissue filling hair follicles and sebaceous glands, yet the fungus does not typically lead to inflammation or immune response in the tissue of hibernating bats (Meteyer et al. 2009).

Through April 2009, the WNS fungus has been isolated from four species of bats including little brown (*Myotis lucifugus* Le Conte), northern long-eared (*Myotis septentrionalis* Trovessart), big brown (*Eptesicus fuscus* Beauvois), and tricolored bats (*Perimyotis subflavus* Menu). Initial analysis of small subunit (SSU) and internal transcribed spacer (ITS) rRNA gene sequences placed this fungus into the genus *Geomyces.* The fungus produces arthroconidia on verticillately branched conidiophores and on prostrate hyphae, typical of genus *Geomyces,* but the asymmetrically curved conidia are unlike any described species.

Materials and methods

Isolation & culture

We isolated the fungus from eight infected bats, representing two species, collected in four US states between January and April of 2008 (Table 1). Wing tissue was placed directly onto Sabouraud dextrose agar (Sab dex; BD Diagnostics, Franklin Lakes, NJ) and incubated at 3°C for initial isolation of the fungus. Growth characteristics were determined on cornmeal agar (CMA; Difco, Detroit, MI), with temperature tolerance determined by incubation at 7°C, 14°C, or 24°C.

Table 1. *Geomyces destructans* isolates examined.

NWHC CASE #	Bat (*Myotis*) species	Coll. date	Coll. location	GenBank accession # ITS region	SSU region
20631-21 T*	*M. lucifugus*	2 Feb 2008	Williams Hotel, NY	EU884921	FJ231098
20631-8 PT	*M. lucifugus*	29 Jan 2008	Hailes Cave, NY	EU884920	FJ231097
20674-9 PT	*M. septentrionalis*	18 Mar 2008	Aeolus Cave, VT	FJ170115	FJ231093
20674-10 PT	*M. lucifugus*	18 Mar 2008	Aeolus Cave, VT	EU884922	FJ231094
20682-1 PT	*M. septentrionalis*	21 Mar 2008	Berkshire Co., MA	EU854570	FJ231094
20682-10 PT	*M. septentrionalis*	21 Mar 2008	Berkshire Co., MA	EU854569	FJ231095
20693-1 PT	*M. lucifugus*	26 Mar 2008	Chester Mine, MA	EU884923	FJ231096
22004-1 PT	*M. lucifugus*	1 Apr 2008	Litchfield Co., CT	EU884924	FJ231093

*BPI878935, holotype (T); PT = paratype.

NWHC = US Geological Survey — National Wildlife Health Center

Sequencing & analysis

DNA was extracted from the fungal isolates following the manufacturer's instructions for microLYSIS-PLUS reagent (The Gel Company, San Francisco, CA). We used primers

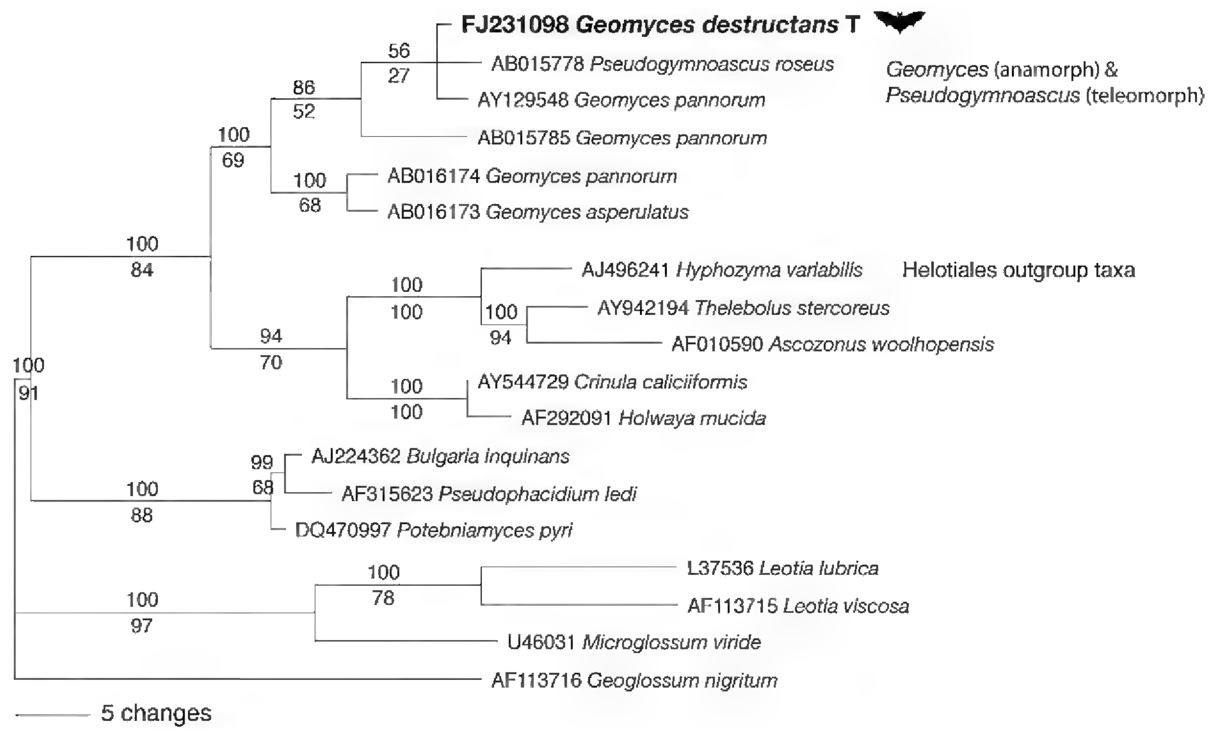

FIG. 1. One of 5 equally parsimonious trees for the SSU alignment (Length = 194, CI = 0.825, RI = 0.807). GenBank accession numbers precede taxon names, the sequence from *Geomyces destructans* is indicated in bold with a bat image, and the type isolate is indicated with a bold capital T. Branch length is relative to the number of substitutions per site. Posterior probability values are shown above each supported node, and bootstrap percentages are shown below supported nodes. Modified from Blehert et al. (2009) online supplement.

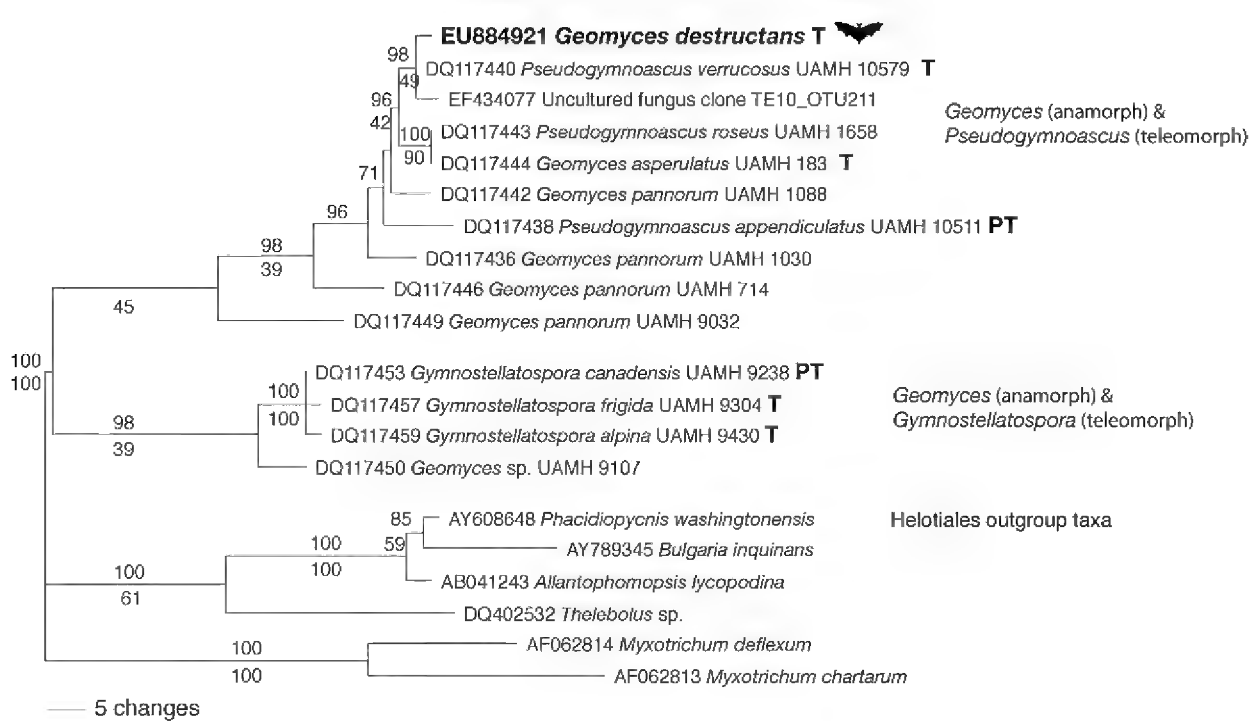

FIG. 2. One of 13 equally parsimonious trees for the ITS alignment (Length = 286, CI = 0.734, RI = 0.805). GenBank accession numbers precede taxon names, and the sequence from *Geomyces destructans* is indicated in bold with a bat image. Type isolates are indicated by bold capital Ts and paratype isolates by bold capital PTs. Branch length is relative to the number of substitutions per site. Posterior probability values are shown above each supported node, and bootstrap percentages are shown below supported nodes. Modified from Blehert et al. (2009) online supplement.

ITS4 and ITS5 (White et al. 1990) and ExTaq proof-reading DNA polymerase (Takara Mirus Bio, Madison, WI) to PCR amplify the rRNA gene ITS region (ITS1, 5.8S, and ITS2). PCR cycling parameters included an initial 2 min denaturation at 98°C, then 30 cycles of denaturation at 98°C for 10 s, annealing at 50°C for 30 s, and extension at 72°C for 1 min, followed by a final extension at 72°C for 7 min. The rRNA gene SSU was amplified as above, but using primers nu-SSU-0021-5' (Gargas & DePriest 1996) and nu-SSU-1750-3' (Gargas & Taylor 1992) and an increased extension time of 2 min. Sequencing primers were the same as PCR primers with the addition of nu-SSU-0402-5' (Gargas & Taylor 1992), nu-SSU-1150-5' (White et al. 1990), nu-SSU-0497-3' (Gargas & Taylor 1992), and nu-SSU-1184-3' (Gargas et al. 1995) for the SSU.

PCR products were sequenced by the University of Wisconsin — Madison Biotechnology Center DNA Sequencing Facility using the BigDye Terminator v3.1 (Applied Biosystems, Foster City, CA) DNA sequencing system. Reaction products were analyzed on an Applied Biosystems 3730xl automated DNA sequencer. Sequencing reaction results for complementary strands were assembled and edited using Lasergene 5.0 (DNAStar, Madison, WI).

Comparative ITS and SSU sequences were selected through BLAST search hits to query WNS strain sequences from similar sequences archived in GenBank. Se-AL (v2.0a11) (Rambaut 2002) was used for visual alignment of the sequences. An ITS alignment of 537 nt for 20 taxa and a SSU alignment of 1725 nt for 18 taxa are archived in TreeBase SN3954-18967, with a substitution of identical sequences for EU884921 for EU854571; and FJ231093 for FJ231098, respectively. We determined parsimony phylograms using PAUP* (4.0b10) (Swofford 2002), and reliability of nodes with Bayesian posterior probabilities calculated with MCMC (MrBayes 3.1.2) (Huelsenbeck & Ronquist 2001, Ronquist & Huelsenbeck 2003) using the GTR model and running four chains with 1,000,000 generations, sampling each 1,000th tree and discarding as burn-in all pre-convergence trees. Bootstrap percentages were based on 1,000 replicates in PAUP* (Swofford 2002).

Results

DNA sequences and phylogenetic analyses

SSU (FJ231098) and ITS (EU884921) DNA sequences for the holotype are archived in GenBank; sequences archived for the paratypes are listed in Table 1; all SSU and all ITS sequences were identical. Although excluded from the sequences used in analysis, the SSU sequences also contain a putative optional group I intron of ca 415 nt, located at small subunit position 1506 (Gargas et al. 1995), with 97% sequence similarity to insertions in *Geomyces* spp. AY345348 and AY345347. Phylogenetic analyses of nuclear rRNA gene SSU (Fig. 1) and ITS (Fig. 2) sequences produced 5 equally parsimonious trees for the SSU and 13 equally parsimonious trees for the ITS, both supporting a close relationship between this fungus and species within the genera *Geomyces* and *Pseudogymnoascus* (Blehert & al. 4/27/2009: http://www.sciencemag.org/cgi/content/full/sci;1163874/DC1).

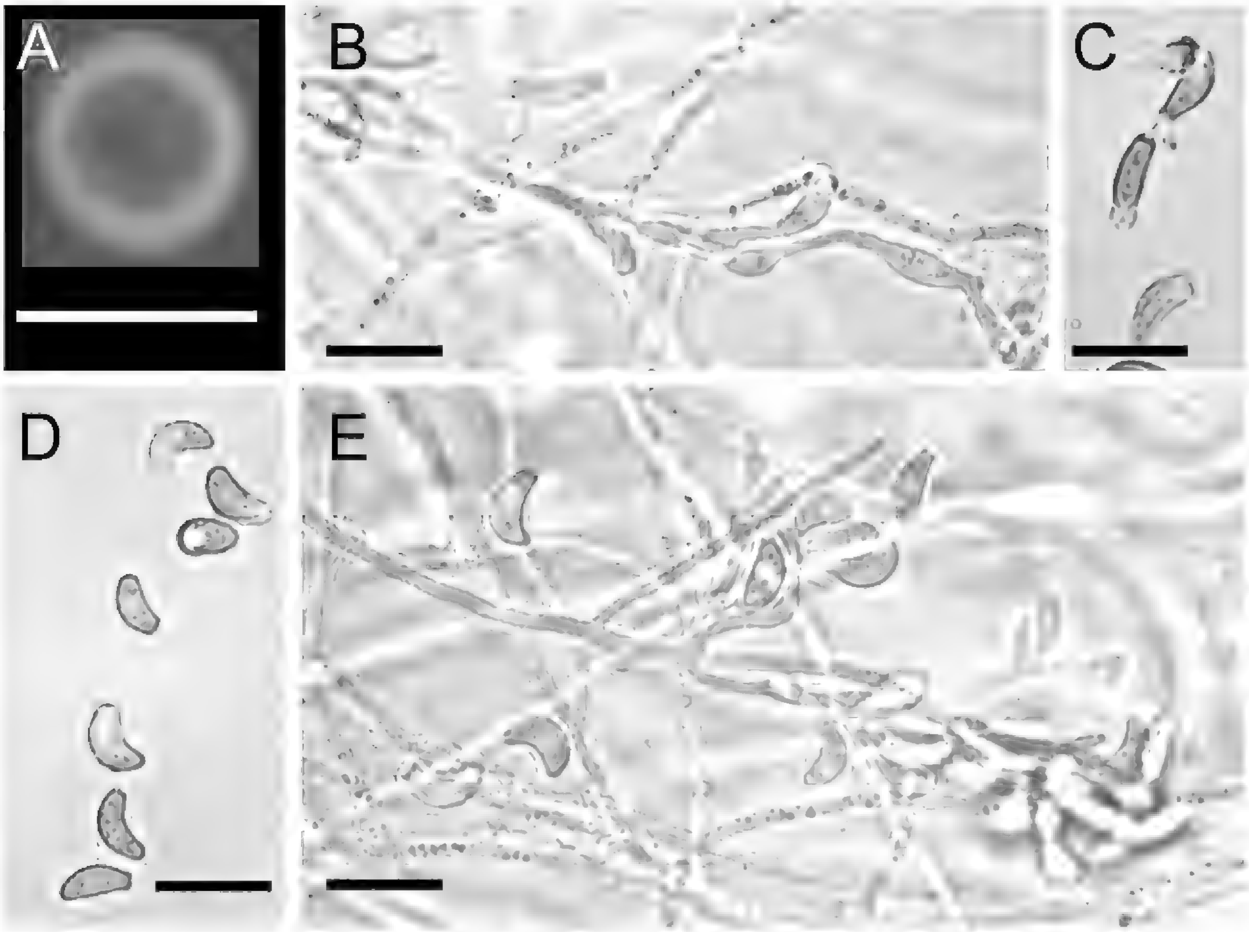

Fig. 3. *Geomyces destructans.* A. Colony on CMA after 16 days at 7°C. B. Conidiophores with conidia in short chains. C. Conidia with separating cell. D. Curved conidia. E. Conidiophores showing acute branching. Scale bars: A = 1 cm, B–E = 10 µm.

Taxonomy

Geomyces destructans Blehert & Gargas, **sp. nov.** Figure 3

MycoBank 513275; GenBank FJ231098, EU884921

Coloniae lente crescendens et psychrophilicae; nullum augmentum ad 24°C. Conidia acervulata pulverulenta, olivaceogrisea. Coloniae incoloratae vel sordidae brunneae ad reversum. Conidiosporae solitariae vel breves catenulatae, plurimum apicales, in erectis angustis verticillatis ramosis conidiophoris. Conidia thallica (arthroconidia) rhexolytica cum conspicuis cellis secedens, glabra aut prope glabra, plurima fortiter incurvata 5–12 × 2.0–3.5 µm, attenuata ad fundamenta et apicaliter ad 0.5–2.0 µm, truncata ad extremo una aut uterque, parce crassitunicata. Pathogenica ad chiropteras.

Type — USA. New York, Williams Hotel Mine, isolated from a wing of a little brown bat (*Myotis lucifugus*), 2 Feb 2008, Al Hicks [NHWC 20631-21] (**Holotype** BPI87895; ex-type culture NHWC 20631-21).

Etymology: *destructans* = destroying

Colonies on CMA (Fig. 3A) and Sab dex agar are slow growing and psychrophilic; colony diameter after 16 days 1.0 mm at 3°C, 5 mm at 7°C, 8 mm at 14°C, no growth at 24°C. Colonies are white marginally and with sterile white overgrowth centrally on Sab dex agar; conidial masses at colony centers

powdery, Gray to Gray-Green near Grayish Olive to Andover Green (Ridgway 1912, XLVI and XLVII); colony reverse uncolored on CMA, becoming Drab to Hair Brown (Ridgway 1912, XLVI) on Sab dex agar.

On CMA, asymmetrically curved conidia borne singly at the tips, on the sides, or in short chains on verticillately branched conidiophores (Fig. 3B). Intercalary conidia (arthroconidia) sometimes with conspicuous separating cells within chains of conidia (Fig. 3C), that undergo rhexolytic dehiscence. Conidiophores are erect, hyaline, smooth and thin-walled, narrow, 1.5–2 µm wide by 35–90 µm or more in length, commonly bearing verticils of 2–4 branches borne at an acute angle to the stipe (Fig. 3E). Branches may appear slightly sinuous due to the presence of curved conidia. Conidia are 5–12 × 2.0–3.5 µm, tapering basally to 1.5–2.0 µm and apically to 0.5–1.5 µm, truncate with prominent scars at one or both ends, smooth and lightly pigmented; predominantly curved, sometimes oval, obovoid, or cymbiform, moderately thick-walled at maturity and readily seceding (Fig. 3D).

Pathogenic to bats.

Additional strains examined: Seven paratypes are listed in Table 1.

Discussion

The outstanding characteristics of *Geomyces destructans* are conidium shape, very slow growth on artificial media, and cold-adaptation with no growth at 24°C or above. This fungus has currently only been identified from tissues of bats, where it invades living tissue (Meteyer et al. 2009) with associated high mortality. Through a combination of traditional morphological studies and molecular analyses we have identified the causal agent of white-nose syndrome cutaneous infection as a new species of *Geomyces: G. destructans.*

Species of *Geomyces* are known from soil worldwide, often from colder regions (see Carmichael 1962, Sigler & Carmichael 1976, Van Oorschot 1980, Sigler et al. 2000, Rice & Currah 2006, Kochkina et al. 2007). In our literature search for species with curved, fusiform conidia in *Geomyces* and closely related genera and among anamorphs of *Pseudogymnoascus*, we found one report of a strain with conidia often or sometimes curved. Among 11 strains of *Geomyces pannorum* from arctic cryopegs and surrounding marine deposits in northern Siberia, Kochkina et al. (2007) isolated a strain (FW-2264) with conidia "often curved, 4.4 × 3.1 µm, scar 1.5 µm". Additionally, this strain was slow growing and was psychrophilic, with spore germination 60% at −2°C and optimum growth at approximately 4°C. In contrast to *Geomyces destructans,* growth at 26°C was about 85 % of that at 4°C and presumably the conidia were echinulate and mostly obovoid.

White-nose syndrome has caused a devastating epizootic among bats of the northeastern US (Blehert et al. 2009), and the disease continues to spread

rapidly. This fungus grows optimally at the temperatures found in winter bat hibernacula. Bats are thought to have lowered immune responses during hibernation torpor (Carey et al. 2003), which may predispose them to infection by *G. destructans*.

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MYCOTAXON

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Opegrapha pauciexcipulata, a new corticolous lichen from Turkey

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Abstract — *Opegrapha pauciexcipulata*, a new corticolous lichen, is described from the centre of Giresun on the Black Sea Coast in Turkey. It is characterized by an open disc and *vulgata*-type ascospores and pycnidia.

Keywords — *Ascomycota*, *Opegraphaceae*, taxonomy, lichen order

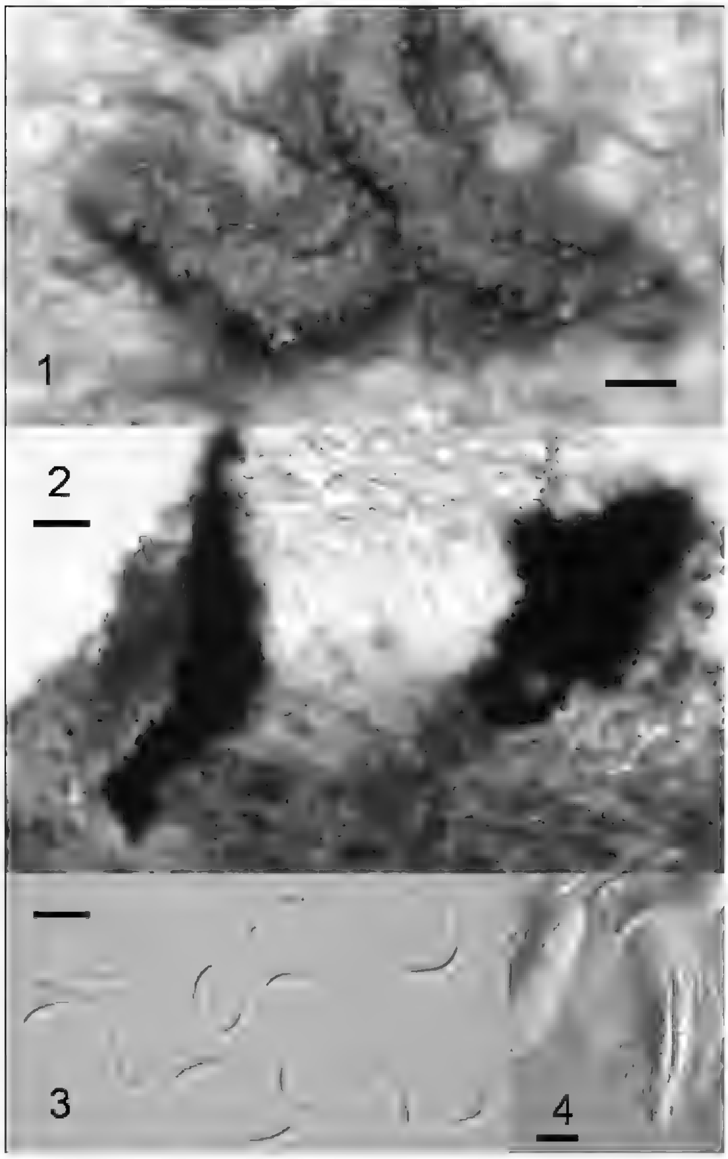
Introduction

During fieldwork by the first author in the past decades, many additions have been found to the lichen flora of Turkey. An inventory of the corticolous lichens on deciduous trees in the city centre of Giresun in Turkey was carried out to map the air pollution (Yazici & Aptroot 2008). One of the species, present with four collections, could not be identified by the second author. It is described here as new to science.

Giresun is a city at the Black Sea coast. The area has a typical oceanic climate with a mild and high precipitation prevailing along the coast. The average elevation is 50 m. The annual temperature is 14.2 °C in the centre of Giresun, while annual precipitation is 1305 mm. On average there are 184 rainy days, 6 snowy days and 11 days with snow cover. Rainy days occur in every season. Common trees in the city centre are *Albizia julibrissin, Robinia pseudoacacia, Salix* sp., *Acer* sp., *Ligustrum* sp., *Platanus orientalis* and *Fraxinus* sp.

Material and methods

All specimens were collected in the city centre of Giresun on the Black Sea Coast in Turkey. The specimens were examined with an Olympus SZX7 dissecting



Figures 1-4. *Opegrapha pauciexcipulata*, isotype.
1. Habitus of apothecium. 2. Section of apothecium.
3. Conidia in tap water. 4. Ascus and ascospores in KOH.
Bar = 0.1 mm in fig. 1; 15 µm in fig. 2; 10 µm in fig. 3; 5 µm in fig. 4.

microscope and an Olympus BX50 compound microscope with Nomarski interference contrast, both with a Nikon Coolpix digital camera attached. Measurements were taken in tap water. Specimens are preserved in the herbarium of Biology Department, Karadeniz Technical University (KTUB), with some duplicates in ABL herbarium.

Taxonomic description

Opegrapha pauciexcipulata Aptroot & Yazici, **sp. nov.** Figures 1–4

MycoBank MB 512909

Thallus corticola, ochracea, prothallo nullo. Apothecia nigra, fusiformes, excipulo dimidiato, hymenio non insperso, subhymenio brunneo. Ascosporae aciculares, plerumque 7–9-septatae, 19–26 × 2.5–3 µm, perisporae gelatinosae 1 µm crassae.

TYPUS: Turkey, Black Sea Coast, Giresun, City centre, 250 m from the Black Sea, 40°55'01"N, 38°23'42"E, alt. 30 m, on *Pyrus* sp., 10 November 2007, Yazici 076, Yazici 0.1348 (KTUB–***holotypus***, ABL–isotypus).

ETYMOLOGY: The epithet "paucexipulata" refers to *paucum* meaning little and *excipulum* meaning apothecium margin.

Thallus corticolous, dull, superficial, c. 0.1 mm thick, not corticate, smooth to rimose, ochraceous, covering an area of up to 4 cm diam, not surrounded by a prothallus. Apothecia unevenly dispersed, sessile, curved to wavy, narrowly fusiform with pointed ends, unbranched or with one or two perpendicular branches, up to 1 mm long, up to 0.3 mm wide, up to 0.1 mm high. Disc pale brown, soon opening and flat, dull, without pruina. Apothecium margin prominent, higher than the disc, black, shiny, c. 0.1 mm wide, often somewhat crenate, without thallus cover. Excipulum dense, black, c. 0.2–0.4 mm wide, absent below the hymenium, where only a mottled brown subhymenium is present. Hymenium not inspersed with oil droplets, c. 60–80 μm high, subhymenium mottled brown. Epihymenium not distinct. Paraphysoids anastomosing, rather knobbly, 2–3 μm wide in KOH. Ascospores acicular to narrowly fusiform, slightly curved, mostly 7 to 9 septa 8/ascus, 19–26 × 2.5–3 μm, surrounded by a 1 μm wide perispore. All parts IKI–negative and KOH–negative. Pycnidia globose, at least semi-immersed in the thallus, brown to black, 0.1–0.2 mm diam. Conidia acrogenous, acicular to filiform, curved, 12–14 × 1–1.5 μm.

Chemistry: K–, C–, KC–, P–, UV–; no substances detected (TLC).

DISTRIBUTION AND ECOLOGY — A corticolous species found in northern Turkey. See Yazici & Aptroot (2008) for a description of the habitat and the accompanying species.

SPECIMENS EXAMINED — **Turkey.** Black Sea Coast, Giresun, City, 250 m from the Black Sea, 40°55'01"N, 38°23'42"E, alt. 30 m, on *Pyrus* sp., 10 November 2007, Yazici 1347 & 1348 (Karadeniz Technical University, Biology Department-topotypes); 650 m from the Black Sea, 40°55'02"N, 38°23'14"E, alt. 40 m, on *Platanus orientalis*, 10 November 2007, Yazici 01349 (KTUB).

COMMENTS — *Opegrapha pauciexcipulata* is well characterized by the weakly carbonized excipulum below the hymenium. This character is known for only a few *Opegrapha* species (Olivier 1914, Poelt 1969, Awasthi 1991, Torrente & Egea 1989), none of which are corticolous or with 7- to 9-septate ascospores. A weakly carbonized excipulum is sometimes observed in specimens of other species with very thin thalli on hard substrates, but this is not the case with the new species.

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Two intimately co-occurring species of *Mycena* section *Sacchariferae* in south-west Australia

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Abstract—Two diminutive, lignicolous species of *Mycena* section *Sacchariferae* are described from Western Australia: *Mycena judithiana* sp. nov. of stirps *Amparoina*, and *Mycena tenerrima* of stirps *Adscendens*. *M. tenerrima* had been unrecorded in Western Australia and unconfirmed in Australia. Six morphological stages of the diphasic mode of development of *M. judithiana* were characterized by observing a succession of basidiomes produced on incubated fragments of wood from which the fungi were originally collected. A wood fragment from which *M. tenerrima* was originally collected yielded basidiomes of that species for the first 25 days of incubation and then also began to produce basidiomes of *M. judithiana*. This indicates how closely the two species can co-occur in south west Australia and perhaps elsewhere.

Key words—*Agaricales*, *Mycenaceae*, taxonomy

Introduction

Mycenoid fungi with diminutive, pale basidiomes are frequently encountered in eucalypt dominated ecosystems of Australia, including those with a granulose, floccose or pulverulent pileus characteristic of *Mycena* section *Sacchariferae* (Grgurinovic 1997, 2003). The granulose pileal surface consists of acanthocysts and sometimes also cherocytes and has been interpreted as a universal veil (Desjardin 1995). A worldwide account of *Mycena* section *Sacchariferae* by Desjardin (1995) arranged 55 epithets into 27 taxa. Some additional taxa to those in Desjardin's account occur in the Asia-Pacific region, e.g. *Mycena vesiculosa* Maas Geest. & E. Horak in New Guinea (Maas Geesteranus & Horak 1995), and *Mycena cupulicola* Issh. Tanaka in Japan (Tanaka & Hongo 2003). Six species of *Sacchariferae* were included in a treatment of Australian *Mycena* by Grgurinovic (2003). To date only one of the species of *Sacchariferae* has been confirmed in Western Australia—*Mycena carmeliana* Grgur. There it has been

recorded from urban bushlands of Perth, remnant natural bushlands in the Western Australian wheatbelt, and in wet eucalypt forests of the south-west (data from the Western Australian Herbarium specimen database).

In this current paper, two species of section *Sacchariferae* recently discovered in Western Australia are treated—*Mycena judithiana* and *Mycena tenerrima*. *M. tenerrima* occurs throughout the world including the Southern Hemisphere, occurring on various woody substrates including conifers and hardwoods (Desjardin, 1995). Although it had not been known in Western Australia, it has been reported in other parts of Australia since the late 19th century (May & Wood 1997). However, Grgurinovic (1997) examined material labelled as *Mycena tenerrima* deposited at MEL and concluded that Australian records of *M. tenerrima* have a misapplied name. The fungus described as *M. tenerrima* by Cleland (1934) from South Australia refers to *Mycena pitereka* Grgur. and *Mycena minya* Grgur., both of which are morphologically distinct from *M. tenerrima* (Grgurinovic 1997).

During this current study, *M. judithiana* was initially collected at Bold Park, an urban bushland in the inner metropolitan area of Perth. This species was collected again 18 days later about 320 km south at the Leeuwin-Naturaliste National Park near Augusta on the south coast of Western Australia. Also, a collection of *Mycena tenerrima* was obtained about 30 meters away on the same day within the same bushland near Augusta. Immediately after collecting them, fragments of the wood on which each of these three collections of *Mycena* were found were incubated at room temperature in separate humid chambers for a period of four weeks. In each case, the wood yielded many specimens of the particular species that originally had been observed on the respective fragments of wood. However, after 25 days incubation the wood fragments on which *Mycena tenerrima* was fruiting began to also yield basidiomes of *Mycena judithiana*, indicating how closely the two species may co-occur in southwest Australia and perhaps elsewhere.

Description of the species

Mycena judithiana Bougher, **sp. nov.** Figs 1–3

MycoBank MB 512875

Pileus 1–3 (6) mm diam; tenuiter carnosa, primo hemisphaericus dein late campanulatus vel convexus, granulosus, primo albus maturitate pallide griseus prope centro. Lamellae adnexae, primo albae dein cremeae, subdistantae, margine fimbriato dein lucenti. Stipes 5–35 × 0.3–1.0 mm, centralis, solidus, basi non tumidus, granulosus, sine disco basali, albus vel sordide cremeus, siccus, cystidiis numerosis digitiformibus. Odor nullus. Sapor mitis. Basidiosporae (6.9) 7.1–7.8 (7.9) × (6.5) 6.7–7.4 µm, hyalinae, dilute amyloideae, subglobosae vel globosae, laeves. Basidia tetraspora, fibulata. Pleurocystidia nulla. Cheilocystidia 18–32 × 9–19 µm, anguste vel late clavata, pyriformia, sphaeropedunculata, vesiculosa, confertim spinulosa, prope basin laevis, spinulae ad 0.8 µm × 0.3 µm, fibulatae. Acanthocystae 15–32 × 9–19 µm, confertim spinulosa, spinulae ad 1.5 × 1 µm, parietibus tenuibus. Cherocytae 9–32 × 9–19 µm, globosae, pyriformes, vesiculosae, irregulares,

FIGURE 1. Mature and primordial basidiomes of *Mycena judithiana* (Holotype). Scale bar = 2 mm.

parietibus crassis (pariete ad 2.4 μm crasso), spinae ad 17 × 6 μm , partim spinulosa, spinulae 1.5–3.5 × 1μm. CAULOCYSTIDIA *15–150 × 8–20 μm, versiformia, clavata vel vesiculosa, cylindrica, sphaeropedunculata vel contorta, confertim spinulosa, spinulae ad 1.5 × 1 μm.* SEPTA HYPHARUM *fibulata. Lignicola, in sylvis, Australia Occidentalis.*

***Holotypus** in herbarium PERTH; Western Australia, Perth, Bold Park, (31°56'31.2"S 115 °46'43.8"E), 11.VI.2008, N.L. Bougher & E. Davison BOUGHER432.*

ETYMOLOGY: 'judithiana' is named after Judith Margaret Bougher (1927–2008).

MACROCHARACTERS — PILEUS 1–3 (6) mm diam., thin-fleshed, hemispherical then broadly campanulate to convex with an irregularly crenate, obscurely translucent-striate, thin margin covered with minute granules including some scattered projecting stalked granules (visible under magnifying lens), white, unchanging with age or attaining a pale grey tinge near center, not bruising. Pileal margin separates from stipe after elongation of the stipe has been completed. Surface dry, persistently granulose — entirely and densely covered by minute white granules in continuous irregular floccose piles. Granules less often forming collapsing, conic, pyramidal or tapering and curved piles of white granules up to 0.2 mm tall. LAMELLAE adnexed, without a pseudocollarium, white at first then cream, ventricose, subdistant, edge white, fringed, glistening, also with granules where near to pileal margin of young specimens, no anastomoses, one lamellulae between most pairs of lamellae, L= 8–9, l = 6–8,

each lamellulae, ventricose and less than half the height and length of the lamellae. STIPE 5–35 × 0.3–1.0 mm, central, slightly tapering towards apex, solid, base unswollen and not inserted in substrate, coherent basal disc absent but base usually with some sparse short white hairs appressed on substrate. Surface dry, with abundant finger-like, round-topped, erect, white cystidia up to 0.1 mm tall, each separated from each other, these easily removed and therefore may be sparse or absent in some specimens particularly when very wet, base of stipe with a short sleeve (0.5–1 mm) of piles of granules similar to those on the pileus. Overall colour white but dull cream when granules and cystidia are sparse revealing the background of the stipe, drying white. ODOUR not distinctive. TASTE mild. SPORE DEPOSIT white.

MICROCHARACTERS — BASIDIOSPORES (6.9) 7.1–7.8 (7.9) × (6.5) 6.7–7.4 µm, mean profile 7.45 × 6.94 µm, mean face view 7.31 × 6.91 µm, mean L/B ratio profile 1.07, mean L/B ratio face view 1.05 (n = 30). Hyaline in 3% KOH or water, weakly amyloid. Subglobose, globose, slightly asymmetrical in profile, smooth, thin-walled. BASIDIA 19–31 × 5–11 µm, clavate to broadly clavate with stalk 4–5 × 2.5–3.5 µm, hyaline, thin-walled, sterigmata to 6 µm in length, 4-spored, clamp connection at base, soon collapsing. Basidia do not mature before the pileal margin expands away from the stipe. LAMELLAE TRAMA tightly packed, parallel, clamped hyphae 2.5–3.5 µm broad, strongly dextrinoid, oeliferous hyphae absent. SUBHYMENIUM hyphae similar to trama. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA abundant, crowded, 18–32 × 9–19 µm, slender or broadly clavate, obpyriform, sphaeropedunculate, vesiculose, with narrow stalk 2.5–5.5 × up to 20 µm , thin-walled, hyaline, clamped at base, densely spinulose except smooth in lower part, spinulae of uniform size up to 0.8 µm tall × 0.3 µm wide at base, obtuse. PILEIPELLIS a hymeniderm when very young then a cutis of thin-walled, sometimes spinulose, dextrinoid, clamped elements 6–16 µm broad, giving rise to prostrate and erect acanthocysts. Cherocytes also scattered on pileipellis. Acanthocysts and cherocytes disarticulating. ACANTHOCYSTS abundant, sometimes detached, 15–32 × 9–19 µm, globose, obpyriform, vesiculose, sphaeropedunculate, thin-walled, hyaline to pale grayish in KOH or water, dextrinoid, entirely densely spinulose, spinulae bluntly conic, obtuse, up to 1.5 µm tall × 1 µm wide at base. CHEROCYTES variable in size and form: 9–32 × 9–19 µm, globose, obpyriform, vesiculose, irregular. Terminals and often subtending elements sometimes thick-walled (up to 2.4 µm), with erect or curved thorn-like spines up to 17 µm long × 6 µm wide at base present usually on only part of each element either densely so or scattered. Elements also are often spinulose at least in part with spinulae 1.5–3.5 µm long × 1µm wide at base. Hyaline in KOH or water, dextrinoid. Cherocytes sometimes catenulate in chains of irregular elements and short hyphae 2–10 µm broad. Others form a globose terminal 21–32 µm diameter arising from an erect,

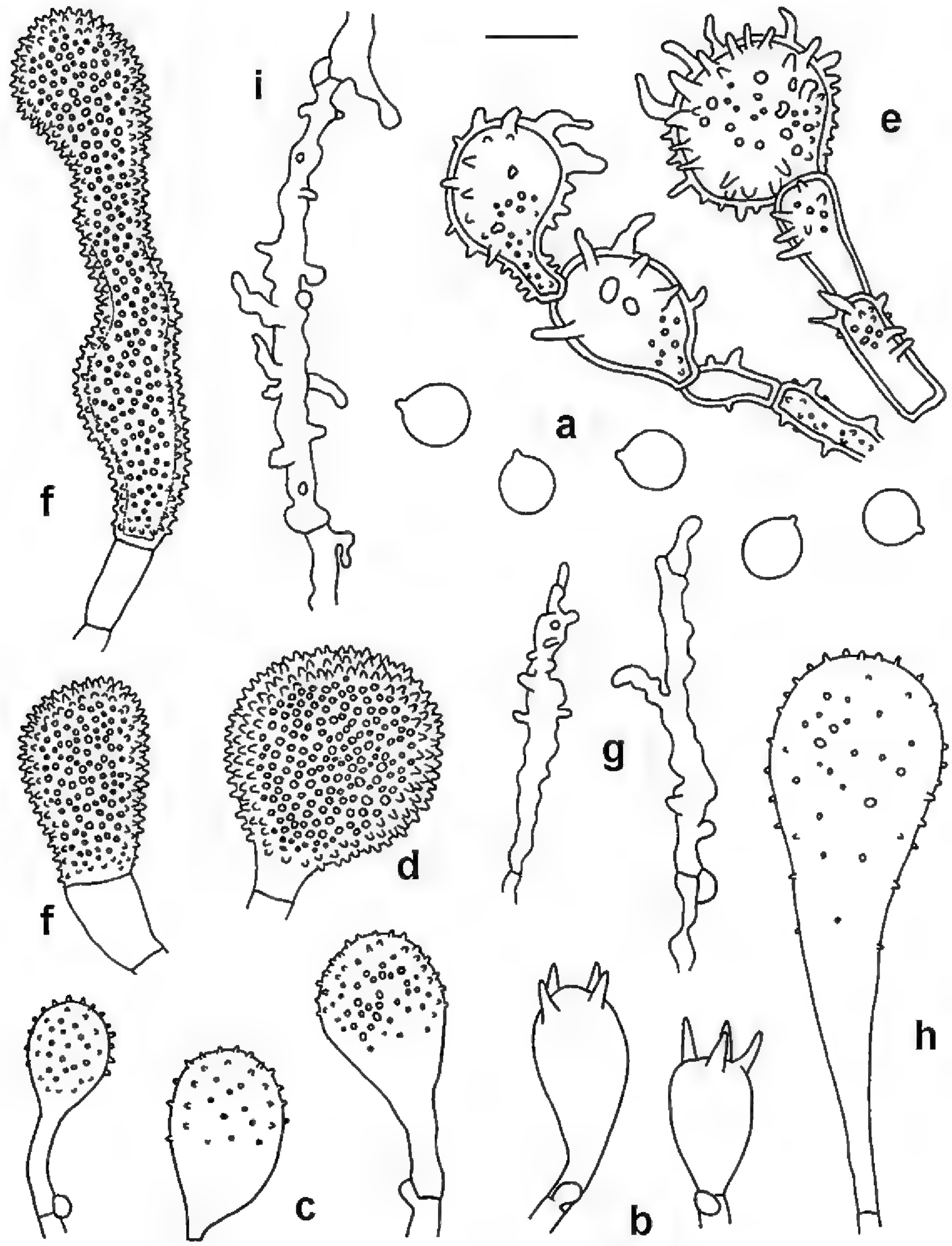

FIGURE 2. Micromorphology of *Mycena judithiana*: a–g Holotype. h, i BOUGHER505 a. Basidiospores. b. Basidia. c. Cheilocystidia. d. Pileal acanthocyst. e. Cherocytes. f. Caulocystidia.g. Cystidia from base of the stipe. h. An acanthocyst from base of the stipe. i. A knobby hypha from the stipe.
Scale bar: = 10 µm.

narrow (2–6 µm broad), smooth-walled or ornamented stalk or chain of elements that projects the terminal cell beyond the pileipellis (FIGURE 2e). Clamps not observed. HYPODERMIUM of thin-walled, smooth, dextrinoid hyphae, swollen up to 150 × 65 µm. PILEAL TRAMA a narrow layer of hyphae similar to hypodermium.

Stipe tissue monomitic, parallel, smooth, thin-walled, clamped hyphae, 3.5–4.5µm broad near surface, wider in interior (up to 15 µm broad), hyaline in KOH or water, dextrinoid. Some hyphae at the surface or in cortex with short, narrow, knobby protuberances and branches (Figure 2i). Caulocystidia abundant on majority of the stipe, some in loose fascicles, 15–150 × 8–20 µm, variable in shape: short forms clavate or vesiculose, longer forms cylindrical, sphaeropedunculate or contorted, with narrow smooth or spinulose stalk 3.5–4.5 µm curving outwards from the parallel hyphae of the stipe, thin-walled except sometimes basally thick-walled up to 1 µm broad, entirely densely spinulose, spinulae of uniform size up to 1.5 µm tall × 1 µm wide at base, conic to obtuse. Hyaline in KOH or water, dextrinoid. No clamps seen at basal septum, but present on next septum. Cystidia at extreme base of stipe contorted, branched, nodulose, thin-walled, up to 80 × 12 µm, hyaline in KOH or water, clamped. Some narrow, tapering hairs, 40–50 × 1.5–2 µm, with minor nodulations, and numerous slender to broadly clavate, sparsely ornamented acanthocysts also present. Detached acanthocysts and cherocytes often present. Clamp connections observed in the pileipellis, lamellae and stipe.

Ecology, range, disribution — Fruiting sparsely but can be spread over many meters on moist, rotting bark and wood of *Banksia* and *Eucalyptus*. On log or in shaded position amid litter on ground in south-west Australia. June-July. Uncommon or overlooked; only 3 collections known.

Specimens examined—**AUSTRALIA. Western Australia: Perth** bold park (31°56’31.2”S 115 °46’43.8”E) — on inside surface of bark of fallen rotting banksia in eucalypt woodland, 11.VI.2008, coll. *N.L. Bougher & E. Davison BOUGHER432* – **holotype** here designated (PERTH). **Shire of Augusta** leeuwin-naturaliste national park, west bay bushland reserve 14779 (34°17’14.3”S 115°09’00.3”E)—on bark of fallen rotting marri (*Corymbia calophylla*) log in eucalypt woodland, 29.VI.2008, coll. *N.L. Bougher & A. Dyson BOUGHER454* (PERTH). **Shire of Augusta** leeuwin-naturaliste national park, west bay bushland reserve 14779 (34°17’13.6”S 115 °09’01.1”E)—on bark of fallen rotting marri (*Corymbia calophylla*) from log in eucalypt woodland incubated in laboratory for 25 days, 25.VII.2008, coll. *N.L. Bougher BOUGHER505* (PERTH).

Comments — The granulose pileus of *Mycena judithiana* distinguishes it and other members of *Mycena* section *Sacchariferae* from the many other superficially similar species of *Mycena* that produce minute white basidiomes on wood or litter in eucalypt-dominated ecosystems and elsewhere. Under a hand lens it may be possible to discern the finger-like caulocystidia of *M. judithiana* and thereby distinguish it from species of *Mycena* such as *M. tenerrima* that have hirsute, pruinose or smooth stipes. Some caution may be required, however, because the caulocystidia of *M. judithiana* appear plump on basidiomes growing in moist situations, but in drier conditions the caulocystidia can become narrower and contorted.

The basidiomes of *M. judithiana* are thin-fleshed and can rapidly shrivel up upon change in moisture or humidity. When they are placed in water, air-dried specimens immediately expand, although they remain somewhat contorted and never fully return to their former pristine shape. This indicates that basidiomes of *M. judithiana* have the capacity to revive in a way similar to that noted by Horak (1980) for *Mycena spinosissima* (Singer) Desjardin, another species of section *Sacchariferae*.

Taxonomic relationships of *Mycena judithiana* — The presence of some thick-walled elements with large projections in *M. judithiana* herein interpreted as cherocytes suggests alignment of this species with the stirps *Amparoina*. This stirps was proposed by Desjardin (1995) to accommodate about one third of known species of *Mycena* section *Sacchariferae* having a universal veil composed of disarticulating acanthocysts and cherocytes. A wide morphological range of thick-walled elements are accepted as cherocytes in *Mycena* species by Desjardin (1995), including forms similar to those occurring in *M. judithiana*.

Spore shape separates *M. judithiana* from the majority of species of *Mycena* section *Sacchariferae* which have ellipsoidal, oblong or pip-shaped spores. The spores of *M. judithiana* are predominantly subglobose and globose with a mean length/breadth ratio 1.07 in profile, and 1.05 in face view. None of the six species of *Mycena* section *Sacchariferae* described for Australia by Grgurinovic (2003) have subglobose spores. Nor do any of the eight species accepted in stirps *Amparoina* by Desjardin (1995). One of the eight species, *M. trichocephala* Singer, has been recently ejected and allied to section *Longisetae* by Desjardin et al. (2002). Three species of *Mycena* section *Sacchariferae* with subglobose spores but not placed within stirps *Amparoina* by Desjardin (1995) are *M. corynephora* Maas Geest., *M. yalensis* Singer, and *M. pulvinibasis* Desjardin. *M. corynephora* from Europe is similar to *M. judithiana* in having short and long caulocystidia and a habit on bark (in its case on *Aesculus*), but differs by having larger spores (mean 8.5 × 7.6 µm). *M. pulvinibasis* from Madagascar differs from *M. judithiana* by lacking caulocystidia., *M. yalensis* from Argentina is perhaps the closest species to *M. judithiana* as it has short and long caulocystidia, relatively small subglobose spores (mean 7.1 × 6.1 µm), and a habit on bark (in its case on *Alnus*). However, *M. yalensis* does not have cherocytes and is placed in stirps *Alphitophora* (Desjardin 1995).

Basidiome development of *Mycena judithiana* — Successive basidiomes produced during incubation in humid chambers enabled the development of the pileus and stipe and their surface structures to be tracked. For the first 3 weeks of incubation, many new fully formed and expanded basidiomes of *M. judithiana* were produced on wood fragments. After that period an increasing number of basidiomes produced a typically long stipe but their pilei

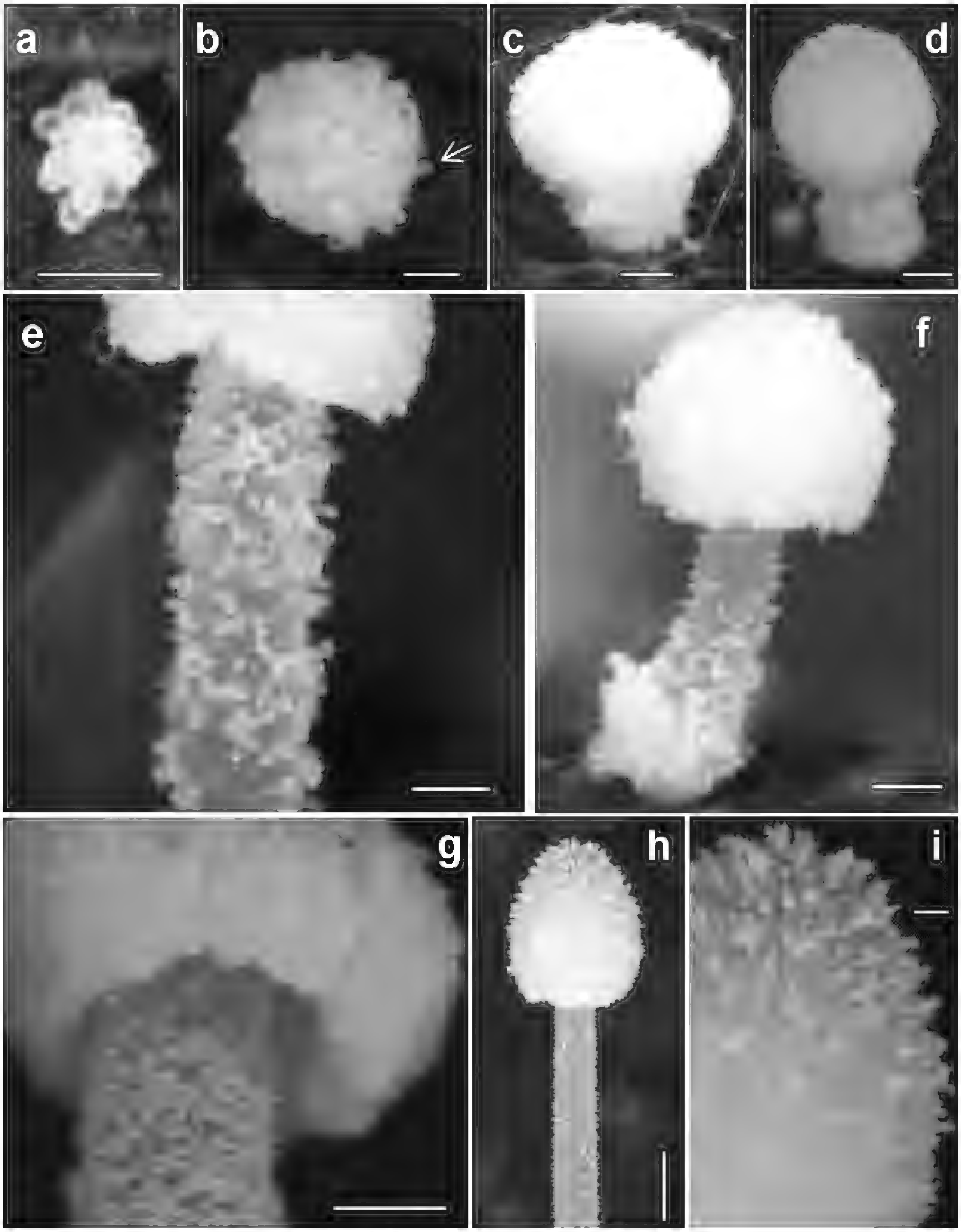

Figure 3. Basidiome development of *Mycena judithiana*: a, h, i BOUGHER454; b–g Holotype. a. Stage 1 (top view) – a recently initiated primordium appearing as a minute bundle of globose granules. b. Stage 2 (top view) – a more compact primordium, with some globose granules projecting beyond the surface (arrow). c. Stage 3 (side view) – a primordium with obpyriform shape and entirely covered with granules. d. Stage 4 (side view) – a primordium outwardly displaying a distinct stipe and pileus for the first time. e. Stage 5 (side view) – a rapidly elongating stipe now free of granules and with abundant acanthophysoid caulocystidia exposed. f. Stage 5 (side view) – a dense covering of granules remaining on the pileus and at the base of the stipe. g. Stage 5 (side view) – a crenate pileus margin clasping near to the stipe. h. Stage 6 (side view) – an ovoid,

remained unopened—perhaps due to exhaustion of the limited resources of the incubated wood fragments. Basidiomes of *M. judithiana* that were produced for the first time after 25 days incubation on the wood fragment from which *Mycena tenerrima* had been fruiting were fully expanding. That particular wood fragment was larger than fragments on which the other collections had been fruiting, perhaps providing greater resources to the fungus.

Observations on variously-aged basidiomes showed that *M. judithiana* has a diphasic mode of development. As outlined by Corner (1994) for *Mycena*, the diphasic mode is whereby the whole basidiome is grown within an unexpanded hemispherical primordium, followed by extension of the stipe, and then by expansion of the pileus. Corner (1994) determined that this mode of development is most pronounced in *Mycena* section *Basipedes* and perhaps also in section *Sacchariferae*. Kühner (1938) examined the diphasic basidiome development of one species of *Sacchariferae—Mycena tenerrima*. Stages 1 to 6 as defined below for *M. judithiana* spans a period of approximately 4 to 5 days.

Stage 1 (fish eggs stage): The youngest primordia of less than about 120 μm in diameter consist of white globose granules aggregated into an irregular-shaped mass, resembling a bundle of minute fish eggs (Figure 3a).

Stage 2 (sessile hemispherical stage): More granules are produced to form a more compact, sessile, semi-hemispherical or cushion-shaped primordium approximately 0.25–0.4 mm in diameter (Figure 3b). A narrow, dense band of short hairs develops at the base of stage two primordia. The young primordia are soft, easily broken by touch, and readily removed from the substrate. Some of the granules appear to be stalked and project beyond the main layer of granules (as visible under magnifying lens). The granules of *M. judithiana* primordia (and also on mature basidiomes) are acanthocysts and cherocytes. Stalked, projecting granules are mostly cherocytes (see Figure 2e). At the early stages of development the primordia are composed almost entirely of acanthocysts and cherocytes, with a central core of tissue which begins developing into the pileus and stipe.

Stage 3 (pyriform stage): The primordia begin to extend vertically and transform into a squat obpyriform form approximately 0.5–1 mm in diameter (Figure 3c). The primordium is entirely covered by granules, and a band of basal hairs remains narrow and dense. During this stage a central core has differentiated into a vestigial pileus and stipe and has determined the obpyriform

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unexpanded pileus on a fully elongated stipe. i. Stage 6 (side view) – erect piles of granules on the pileal surface of a pristine basidiome (piles are also evident in Fig. 3h).

Scale bars: a, b = 0.1 mm; c, d = 0.3 mm; e, f, g = 0.4 mm; h = 1 mm; i = 0.2 mm.

shape of the primordium, but the pileus and stipe are not yet distinguishable in surface view.

Stage 4 (initial emergence of stipe and pileus): Upon further vertical elongation of the primordia, the pileus and stipe become outwardly distinguishable for the first time (Figure 3d). The pileus is now more or less globose and entirely covered by granules but has not increased in size from the previous stage. The pileus has been elevated by the stipe which is just about to begin its phase of rapid elongation. At this stage the stipe appears as a cylinder only about 0.1–0.4 mm tall and is entirely covered with overlapping, dense piles of granules. The stipe is still subtended by a basal band of short hairs which has so far remained intact but will usually begin to deteriorate from now onwards.

Stage 5 (rapid elongation of stipe): During the early elongation of the stipe, when it is only approximately 1–2 mm tall, its surface begins to attain its mature form. The stipe is now no longer covered by overlapping piles of granules, but reveals long, plump, often erect acanthocysts that are in loose fascicles and become increasingly separated from each other (Figure 3e). Near the base of the stipe a sleeve of dense, overlapping piles of granules persists (Figure 3f). These granules may reach all the way to the substrate depending upon the integrity of the basal band of short hairs. In most cases the hairs have by now become less densely arranged and mainly appressed to the substrate. The pileus gradually gains more width than height to attain a more ellipsoidal or hemispherical shape, but the pileal margin remains clasped near to the stipe while the phase of rapid elongation of the stipe continues. The clasped or slightly separated margin is crenate and covered with abundant piles of granules (Figure 3g).

Stage 6 (stipe elongated, pileus expands): The stipe elongates to its full length and at first has an unexpanded pileus (Figure 3h). Then after elongation of the stipe has been completed the pileus expands to its maximum size and the pileal margin separates from the stipe to expose the lamellae. As in earlier stages, the surface of the expanding pileus is covered with overlapping, dense piles of granules. In most specimens of *M. judithiana* the piles are irregular and sit mainly flat on the surface. However, in some pristine, larger specimens (e.g. with unopened pilei up to 2–2.5 mm tall) the granules may be arranged into conic, pyramidal or tapering and curved piles of white granules up to 0.2 mm tall (Figure 3i). These erect piles are not removable as an intact unit as they are very fragile and crumble upon any attempt to remove them. Macroscopically, and under a high powered lens, the granules comprising the erect piles of *M .judithiana* appear indistinguishable from the granules in the intervening areas and from those forming the flatter piles of granules more typical of this species. Granules in the both the erect piles and in the intervening flat areas

are composed of acanthocysts and cherocytes. The erect piles of *M. judithiana* rapidly disassociate and disappear after early stages of basidiome development, and there are rarely any such piles remaining at maturity. Some other species of *Mycena* section *Sacchariferae* such as *Mycena spinosissima* and *M. heteracantha* (Singer) Desjardin are known to have well developed conic to pyramidal pileal piles up to 2 mm tall (Horak 1980, Desjardin 1995, Takahashi 1999). The erect piles of *M .judithiana* are shorter and more variable than in those species.

During observations of primordial development it became evident that young primordia of *M. judithiana* were grazed upon heavily and often completely disassociated by collembolla and minute mite-like arthropods. The creatures were observed scattering granules by default around the vicinity of grazed basidiomes and sometimes transporting some granules as they crawled away. It is not known if the granules of *M. judithiana* could act as propagules, and if the wood-inhabiting arthropods provide another option for dispersal of this species. Acanthocysts and cherocytes of other species in *Mycena* section *Sacchariferae* have been shown to germinate on agar (Singer 1983, Desjardin 1995).

Mycena tenerrima (Berk.) Quél., Mém. Soc. Émul. Montbéliard, sér. 2, 5: 109 (1872), as *'tenerrimus'*. FIGS 4–5

= *Agaricus tenerrimus* Berk., in Engl. Fl. 5(2): 61 (1836).
≡ *Prunulus tenerrimus* (Berk.) Murrill, N. Amer. Flora 9: 322 (1916).
≡ *Pseudomycena tenerrima* (Berk.) Cejp, Publ. Fac. Sci. Univ. Charles 104: 151 (1930).

= *Agaricus farinellus* Feltgen, C.R. Soc. Natn. Luxemburg 16: 145 (1906).
≡ *Mycena farinella* (Feltgen) Sacc. & Trotter, Syll. Fung. 21 : 58 (1912).

MACROCHARACTERS — PILEUS 1–5 mm diam., thin-fleshed, sessile and cushion-shaped (hemispherical) at button stage, then convex, not usually becoming campanulate, with broadly flattened apex from which shallow radial grooves extend to the pileal margin, uniformly white to pale cream or sometimes slightly darker or dull at centre, not bruising, obscurely translucent-striate when moist. Margin thin, entire, incurved at first, not upturning with age, covered with granules some of which extend over the margin, wavy in older specimens. Surface dry, densely granulose when young with abundant, minute, white spherical granules not organized into raised piles, furfuraceous at maturity with scattered and sometimes inconsistent covering of granules. LAMELLAE shallow or broadly adnexed, pseudocollarium not well developed and sometimes may be absent white at first then cream, ventricose, subdistant, edge cystidiate and slightly paler than face, no anastomoses, one (mostly) to three lamellulae between pairs of lamellae, e.g. L= 18, l = 12, most lamellules less than half the height and length of the lamellae. STIPE 5–25 × 0.2–1.2 mm, central, equal or slightly tapering towards apex, solid becoming hollow, white

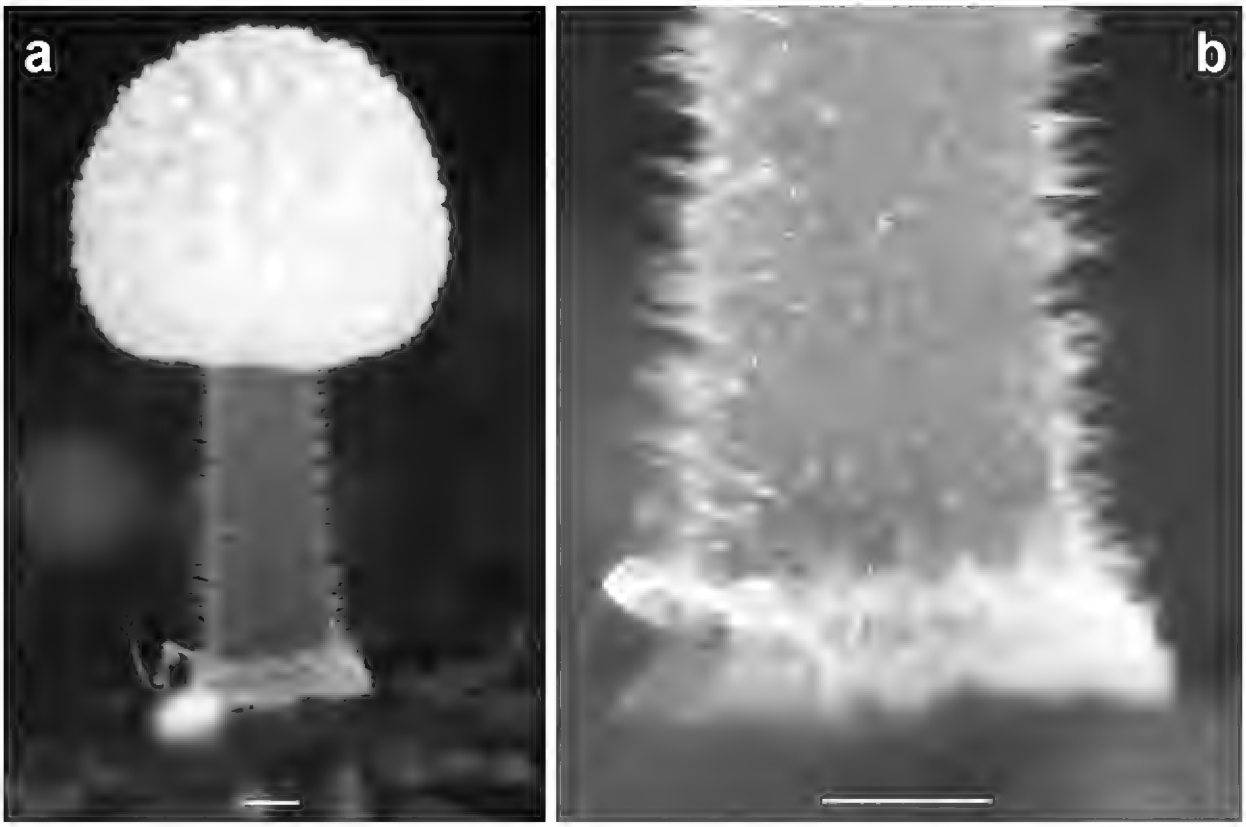

FIGURE 4. *Mycena tenerrima* (BOUGHER453): a. Granulose pileus, stipe with long, hair-like cystidia, and basal disc with dense, short hairs. b. Closer view of caulocystidia and stipe base. Compare and contrast with stipe of *M. judithiana* (FIGS 3e, f, p. 166). Scale bars = 0.5 mm.

to dull grey especially in lower half, becoming semi-translucent when older, entirely covered with soft, white hairs when young, later the hairs may be less abundant in upper half of the stipe and eventually become scattered or disappear. Water droplet visible (with hand lens) at apex of many hairs in moist conditions. Base not inserted in substrate, slightly wider than the stipe with a compact, narrow collar approximately 0.5 mm wide of dense, short, erect, white hairs (FIGURE 4). ODOUR not distinctive. TASTE mild. SPORE DEPOSIT white.

MICROCHARACTERS — BASIDIOSPORES (7.5) 7.6–8.8 (9.0) × (4.4) 4.5–5.3 µm, mean profile 8.23 × 4.83 µm, mean face view 8.17 × 4.82 µm, mean L/B ratio profile 1.70, mean L/B ratio face view 1.69 (n = 30). Hyaline in 3% KOH or water, weakly amyloid. Ellipsoidal, pip-shaped, or oblong, asymmetrical in profile, smooth, thin-walled. BASIDIA 15–19 × 5–9 µm, clavate to broadly clavate with stalk 4–5 × 2.5–3.5 µm, hyaline, thin-walled, sterigmata to 6 µm in length, 2-spored, clamp connection at base, sterigmata up to 5 µm long. Lamellae trama clamped, hyphae swollen at maturity up to 20 µm broad. SUBHYMENIUM narrow layer of clamped hyphae 2–2.5 µm wide. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA abundant, forming sterile gill edge, basal portion 12–32 × 5–12 µm, sometimes clavate to ventricose (when immature?), usually lageniform with a single, long, narrow, smooth-walled rostrum (less often two)

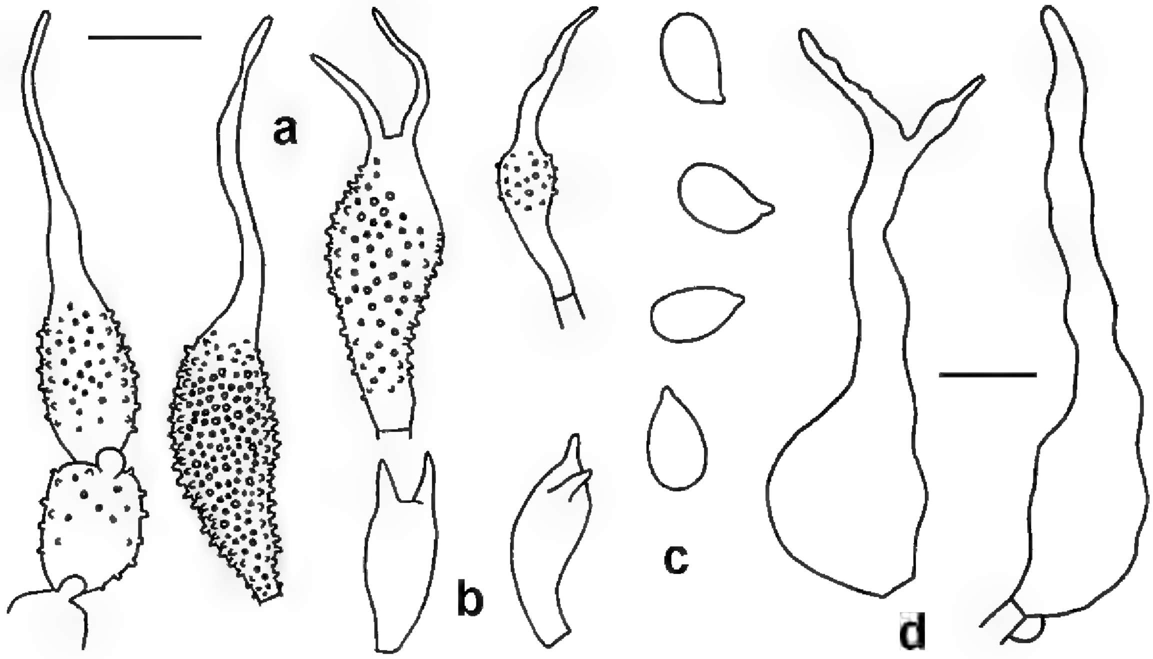

Figure 5. Micromorphology of *Mycena tenerrima* (BOUGHER453): a. Cheilocystidia. b. Basidia. c. Basidiospores. d. Caulocystidia. Scale bars: a–c = 10 µm; d = 10 µm.

up to 35 µm long. Entire basal portion and subtending cell densely spinulose or ornaments absent in lower part and subtending cell. Pileipellis a cutis of clamped smooth-walled or spinulose hyphae 3–10 µm broad, with abundant terminal acanthocysts in palisade-like arrangement and subtended by short chains of ornamented cells in young basidiomes. Acanthocysts 10–36 × 10–26 µm, clavate to vesiculose, rarely with one or two apical projections, entirely covered with crowded, cylindric, obtuse spinules up to 2 × 1 µm. Hypodermium of thin-walled, smooth, clamped, dextrinoid hyphae swollen up to 70 × 30 µm. Pileal trama a narrow layer of hyphae similar to hypodermium. Stipe tissue monomitic, parallel, smooth, thin-walled, clamped hyphae, 3.5–4.5 µm broad near surface, wider in interior (up to 15 µm broad), hyaline in KOH or water, dextrinoid. Caulocystidia scattered singly or in small clusters, 50–110 × 6–18 µm, lanceolate to slender lageniform, smooth, thin-walled, hyaline in KOH or water, inamyloid, apex sometimes with two or more contorted, dendritic branches, clamped at base. Branched caulocystidia sometimes with a water droplet at the apex (visible with hand lens). Cystidia of basal disc a dense palisade of variable elements including chains of ellipsoidal, globose and elongate cylindric cells 30–70 × 20–25 µm, and cylindric or tapering hair-like elements up to 120 × 3 µm. All elements smooth, thin-walled, clamped. No acanthocysts present in basal disc. Clamp connections present in all tissues.

Habit and Habitat — In Western Australia fruiting singly or gregariously on fallen twigs, branches and logs of *Eucalyptus* and other plants. April-July. Probably

common but overlooked in Australia. Known from 14 sites (15 collections) in eucalypt forests and woodlands in south-west Australia.

Representative Specimens examined — **AUSTRALIA. Western Australia: Shire of Augusta** LEEUWIN-NATURALISTE NATIONAL PARK, WEST BAY BUSHLAND RESERVE 14779 (34°17'13.6"S 115 °09'01.1"E)—on bark of fallen rotting marri (*Corymbia calophylla*) log in eucalypt woodland, 29.VI.2008, coll. *N.L. Bougher & A. Dyson BOUGHER453* (PERTH). **Sutton Forest Block** 2.1 KM WEST OF LOCKYER ROAD ON CRIPPLE ROAD (34°29'42"S 116 °18'03"E)—in regenerated karri (*Eucalyptus diversicolor*) forest, 9.VI.1999, coll. *R.M. Robinson FF791* (PERTH). **Flybrook Forest Block** 500 M SOUTH OF FLYBROOK ROAD ON TANK ROAD (34°28'35"S 115 °51'20"E)—on twig of *Trymalium floribundum* in regenerated karri (*Eucalyptus diversicolor*) forest, 16.VII.2002, coll. *R.M. Robinson & R.H. Sutton 1617* (PERTH).

Comments — The Western Australian collections described above conform to *M. tenerrima* by having a combination of the following characters: (i) bisporic basidia; (ii) cheilocystidia with an ornamented swollen basal portion and often a smooth, long rostrum; (iii) abundant acanthocysts rendering the pileus densely granulose; (iv) smooth, slender caulocystidia; (v) basal disc comprised of variable cystidia, including some in chains; (vi) clamp connections present in all tissues. *Mycena tenerrima* var. *carpophila* J.E. Lange differs by having quadrisporic basidia and narrower spores (Desjardin 1995, Tanaka & Hongo 2003).

The mean spore size of the Western Australian specimens (profile 8.23 × 4.83 µm, face view 8.17 × 4.82 µm) is lower than Desjardin's (1995) data for *M. tenerrima* [as *Mycena adscendens* (Lasch) Maas Geest. var. *adscendens*] based mainly on North American collections (9.6 × 5.4 µm). However, the Western Australian spores [(7.5) 7.6–8.8 (9.0) × (4.4) 4.5–5.3 µm] partially overlap the size range attributed to *M. tenerrima* by Desjardin (1995): 8.3–10.2 (11.2) × (4.8) 5–6 (6.4) µm, and are also within the range (8–11 × 5–6 µm) considered by Desjardin as characteristic of this widespread taxon.

The spores of the Western Australian specimens are similar in size to those of several narrower-spored taxa that closely resemble *M. tenerrima*. The quadrisporic variety *M. tenerrima* var. *carpophila* has spores reported from Europe to be 4–4.5 µm wide (Desjardin 1995), and 3.6–4.8 µm wide from Japan (Tanaka & Hongo 2003). *Mycena nucicola* Huijsman from Europe has spores 4.2 – 5 µm wide, and *M. cryptomeriicola* Imazeki & Toki from Japan has spores 4 – 5 µm wide (Desjardin 1995). However, *M. nucicola* and *M. cryptomeriicola* differ from *M. tenerrima* by having quadrisporic basidia. The basal disc of *M. nucicola* is reported to have acanthocysts (Desjardin 1995), and this also separates it from *M. tenerrima* including the Western Australian specimens which do not have such acanthocysts. *Mycena cryptomeriicola* is also further separated from *M. tenerrima* by having inamyloid spores, no clamp connections, and a habit on coniferous leaves (Maas Geesteranus 1991, Desjardin 1995, Tanaka & Hongo 2003).

Comparison of the two species — *M. judithiana* and *M. tenerrima* are not easily distinguished from each other with the unaided eye. Their similarity is emphasized in circumstances where the species co-occur. The two species can fruit in extremely close proximity. In the current study, fully matured basidiomes of both species simultaneously occurred within 10 mm of each other on a piece of bark only 5 × 2 cm × 5 mm thick. Because of their superficial similarity in the field and the possibility of their close co-occurrence, at least in Western Australia, mixed collections are a distinct possibility. However, these species can be distinguished in the field by using a hand lens to observe the plump caulocystidia of *M. judithiana* that are distinguishable from the hair-like caulocystidia of *M. tenerrima* (compare Figures 3e, f and 4a, b). In drier conditions, the caulocystidia of *M. judithiana* can appear narrower and contorted but are still distinguishable from the soft hairs of *M. tenerrima*. The base of the stipe also distinguishes these species. *M. judithiana* has a non-flaring sleeve of white granules similar to those of its cap surface, while *M. tenerrima* has a flaring collar of dense short hairs. However, in both species the hairs or granules on the base can become disorganized and less distinct in older or water soaked specimens. Microscopically *M. judithiana* and *M. tenerrima* are distinguishable by: (i) subglobose to globose spores of *M. judithiana* compared with the ellipsoidal spores of *M. tenerrima*; (ii) acanthophysoid caulocystidia versus smooth-walled, slender caulocystidia in *M. tenerrima*; (iii) thorny cherocytes present only in *M. judithiana*; (iv) acanthocysts present at the base of the stipe in *M. judithiana* but absent in *M. tenerrima* which has a palisade of variable cystidia including some in chains in the basal disc.

Acknowledgments

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Additions to the graminicolous rust fungi of Pakistan

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Abstract — *Puccinia khanspurica* is described as a new species, with *P. crandallii* and *P. virgata* as new records for Pakistan.

Key words — Khanspur, Nathia Gali, *Poaceae, Pucciniales, Sorghum halepense*

Introduction

Puccinia Pers. is the largest genus of *Pucciniales*, with about 3000–4000 species. Species of *Asteraceae, Cyperaceae, Poaceae*, and *Liliaceae* are hosts for large numbers of species, but numerous other species of *Puccinia* infect plant species of most other groups of vascular plants (Perdomo-Sánchez & Piepenbring 2008). Most members of *Poaceae* are favorable hosts for *Puccinia* and about 650 species of this genus occur on graminaceous hosts worldwide (Afshan et al. 2008a).

Until to 1997, forty-six species of *Puccinia* were known from Pakistan on different members of *Poaceae* (Ahmad et al. 1997). Based on recent work for the enumeration of the graminicolous rust fungi from Pakistan, sixty species of *Puccinia* are now known on graminaceous hosts from this country (Afshan et al. 2007, Afshan & Khalid 2008, Afshan et al. 2008a, b, c, Iqbal et al. 2008).

In the present investigation, three species of *Puccinia* were found infecting three members of *Poaceae*. Among these, *Puccinia khanspurica* on *Sorghum halepense* is new to science. *P. crandallii* on *Poa tibetica* and *P. virgata* on *Panicum antidotale* are additions to the rust fungi of Pakistan.

Materials and methods

Freehand sections of infected tissue and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed. Drawings of spores and paraphyses were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken using an ocular micrometer. At least

25 spores were measured for each spore stage. The rusted specimens have been deposited in the herbarium of the Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia khanspurica Khalid & Afshan, **sp. nov.** (Figs. A–B, Table 1)
MycoBank MB 512891

Spermogonia et aecia ignota. Uredinia amphigena, brunnea, striiformia. Urediniosporae globosae, ovoideae vel ellipsoideae; 19–25 × 21–29 µm; membrana 1.5–2 µm crassa, pallidae-brunneae, delicate vel striolatae verrucosae; poris germinationis 2–4, aequatorialibus, pedicellis hyalinis, usque ad 15 µm longis. Paraphysibus clavatis vel capitatis, brunneae, basaliter hyalinae vel pallidae-brunneae, apice 10–17 µm crasso, basaliter 5–8 µm crasso, membrana 3–4 µm crasso, usque ad 95 µm longo. Telia amphigena, subepidermalia, atra, striiformia. Teliosporae 1–4 cellulares, clavatae, ellipsoideae vel cylindricae; 14–24(–26) × (42–)56–66(–74) µm, membrana 1.5–2.5 µm crassa, apicaliter brunneae vel cinnamomea-brunneae, basaliter pallidae, pariete levi; apice truncato vel rotundatis; pedicello brunneo, usque ad 6–7 × 9–11 µm; paraphysibus brunneae, clavatae, usque ad 50 µm longis.

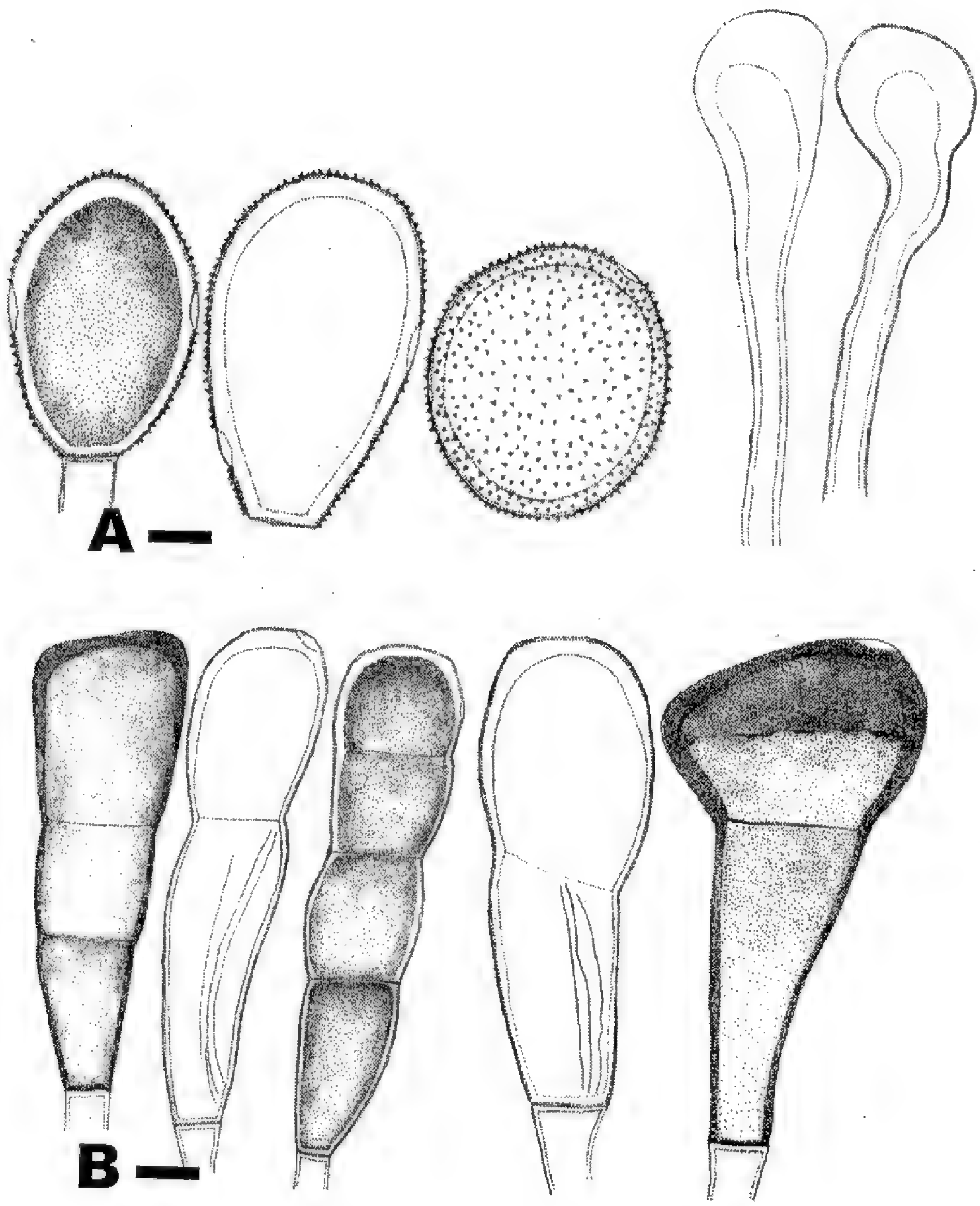
Holotype: On *Sorghum halepense* (L.) Pers., with II & III stages, Pakistan, North Western Frontier Province (NWFP), Khanspur, Helipad, at 2575 m a. s. l., 23rd May, 2006. NSA # 37. (LAH Herbarium No. NSA 1061).

Etymology: Named after the locality, Khanspur.

Spermogonia and aecia unknown. Uredinia amphigenous, 0.09–0.2 × 0.2–0.4 mm, golden brown, solitary or sometimes in linear rows. Urediniospores globose or ovoid to ellipsoid, (19–)21–25 × 21–29 µm; wall 1.5–2 µm thick, pale brown to golden brown, finely verrucose or striolate verrucose; germ pores 2–4, equatorial; pedicel hyaline, short, up to 15 µm long. Paraphyses numerous, clavate to capitate, golden brown, but hyaline to pale brown basally, apex 10–17 µm thick, 5–8 µm thick at base, wall 3–4 µm at sides while 6–11 µm at apex, up to 95 µm long. Telia mostly amphigenous, black, striated, subepidermal, 0.09–0.1 × 0.1–0.3 mm. Teliospores 1–4-celled, mostly 2-celled, papery, clavate or ellipsoid to broadly ellipsoid or mostly cylindrical, 14–24(–26) × (42–)56–66 (–74) µm; wall 1.5–2.5 µm thick, golden brown to cinnamon brown apically, pale brown basally, smooth; apex mostly truncate, sometimes rounded, 4–12 µm thick; germ pore 1 per cell; pedicel short, brown, 6–7 × 9–11 µm. Paraphyses brown, few, clavate, surrounding the sori, 4–6 × 47–50 µm.

Comments: Rust fungi reported on *Sorghum* spp. include *P. levis* var. *panici-sanguinalis* (Rangel) Ramachar & Cummins, *P. nakanishikii* Dietel, *P. purpurea* Cooke and *Uredo geniculata* Cummins (Cummins 1971).

Puccinia khanspurica is characterized by the presence of 1–4-celled teliospores with shorter pedicels. Moreover, the presence of thicker apices of teliospores with papery, clavate or ellipsoid to broadly ellipsoid or mostly cylindrical shape makes it different from other *Puccinia* species reported on



Figs. A–B: Lucida drawings of *Puccinia khanspurica* (holotype).
A. Echinulated urediniospores with capitate paraphyses;
B. 2–4-celled teliospores.
Scale bar = 10 µm.

the same host or the same tribe. (A comparison of *P. khanspurica* with similar species is presented in Table 1)

Puccinia purpurea resembles *P. khanspurica* in having subepidermal telia, smooth teliospores and clavate to capitate uredinial paraphyses. However, *P. khanspurica* is different by smaller urediniospores and thin, longer teliospores. In addition, number and distribution of germ pores and wall ornamentation of urediniospores are different in the *P. khanspurica* and *P. purpurea*.

P. khanspurica has few characters similar to *P. nakanishikii* including the presence of clavate to capitate paraphyses and smooth teliospores. But it can

TABLE 1. Comparison of *Puccinia khanspurica* with similar *Puccinia* spp.

Puccinia khanspurica	*Puccinia purpurea*	*Puccinia nakanishikii*	*Puccinia pygmaea*	*Puccinia recondita*	*Puccinia poarum*
Uredinia					
amphigenous, subepidermal	abaxial, pulverulent	amphigenous or abaxial	unknown	often amphigenous	adaxial
Urediniospores					
globose or ovoid to ellipsoid	ellipsoid, obovoid, nearly globoid, often angular	oval or obovoid	ellipsoid, broadly ellipsoid or obovoid	broadly ellipsoid or obovoid	obovoid or ellipsoid
pale brown to golden brown	cinnamon brown to dark brown	dark cinnamon brown to chestnut brown	yellow to cinnamon brown	yellowish brown to cinnamon brown	colorless or pale yellow
finely verrucose or striolate verrucose	echinulate	echinulate	finely echinulate	echinulate	echinulate
germ pores					
2–4, equatorial	5–8, scattered, tending to be bizonate	4–5, equatorial	6–10, scattered, obscure	6–10, scattered	4–8, scattered
size					
21–25 × 21–29 µm	23–32 × 26–40 µm	17–26 × 26–38 µm	18–26 × 24–35 µm	17–28 × 20–36µm	14–26 × 21–37 µm
paraphyses					
clavate to capitate, golden brown, numerous	clavate–capitate, hyaline to yellowish	clavate–capitate, yellow to golden	capitate or clavate–capitate	unknown	capitate, short, few
Teliospores					
amphigenous, subepidermal, loculate	compact, pulvinate, exposed	compact, early exposed	abaxial, subepidermal	abaxial or adaxial, subepidermal	abaxial, subepidermal
1–4-celled, mostly 2-celled	2-celled	2-celled	2-celled	2-celled	2-celled
clavate, ellipsoid, broadly ellipsoid, or mostly cylindrical	ellipsoid or oblong–ellipsoid	mostly ellipsoid	oblong–obovoid or oblong	oblong–clavate	elongately obovoid or oblong–clavate
golden brown–cinnamon brown, paler basally	chestnut brown	chestnut brown	unknown	chestnut brown	chestnut brown above, golden basally
14–24 × 56–66 µm	22–33 × 37–55 µm	16–28 × 29–48 µm	14–26 × 32–58 µm	12–25 × 32–75µm	14–28 × 36–77 µm
apex					
4–12 µm thick	4–7 µm thick	4–8 µm thick	2–6 µm thick	3–7 µm	2–8 µm
pedicel					
brown, 6–7 × 9–11 µm long	hyaline to yellow, ≤ 95 µm long	brown, collapsing, ≤ 65 µm long	yellow, ≤ 15 µm long	brown, ≤ 20 µm long	colorless or yellow, ≤ 15 µm long

be separated from the *P. nakanishikii* on the basis of 2–4-celled teliospores with thicker apices and finely verrucose or striolate verrucose urediniospores. *Puccinia nakanishikii* has only 2-celled teliospores with thinner apices and echinulate urediniospores. Other features that separate the two species are larger urediniospores and teliospores of the *P. khanspurica*.

Puccinia khanspurica can be separated from *P. pygmaea* Erikss. by the size of spores. *P. khanspurica* has smaller urediniospores and longer teliospores than *P. pygmaea*. Other differences are the presence of finely verrucose or striolate verrucose urediniospores with up to 4 equatorial germ pores and 1–4-celled teliospores in the *P. khanspurica* in contrast to *P. pygmaea* that has echinulated urediniospores with 6–10 scattered germ pores and only 2-celled teliospores.

Puccinia recondita Dietel & Holw. can be separated by the size and wall ornamentation of urediniospores which are smaller in *P. khanspurica* than in *P. recondita*. In addition, *P. recondita* possesses 6–10, scattered germ pores in the urediniospores and only 2-celled teliospores.

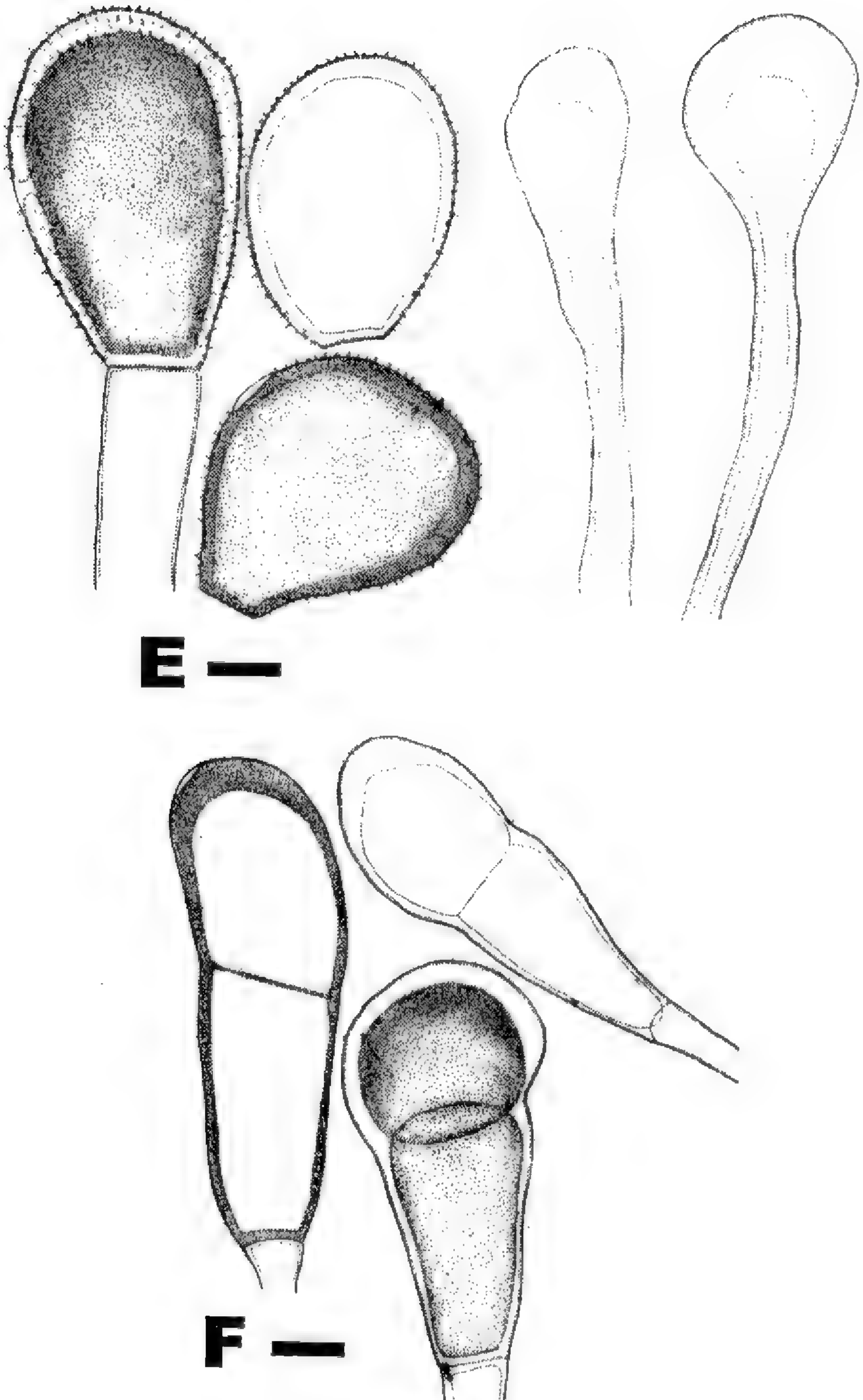
Puccinia khanspurica has some resemblance with *P. poarum* E. Nielsen by the size of teliospores. But it can be separated by the presence of 1-celled teliospores and size of urediniospores that are shorter in *P. khanspurica*. Other differences are the presence of finely verrucose or striolate verrucose urediniospores with 2–4, equatorial germ pores in *P. khanspurica* than in *P. poarum*.

Puccinia crandallii Pammel & H.H. Hume,
in Hume, Proc. Davenport Acad. Nat. Sci. 7: 250 (1899) (Figs. C–D)

Spermogonia and aecia not found. Uredinia amphigenous, subepidermal, light brown to golden brown, 0.09–0.1 × 0.1–2.0 mm. Urediniospores ovoid to obovoid or ellipsoid, (12–)19–22 × 17–26(–30) µm; wall 1–1.5 µm thick, pale brown to cinnamon brown, echinulate; germ pores 5–7, scattered, obscure; pedicel hyaline, 5–6 µm wide and up to 35 µm long. Telia amphigenous, covered by the epidermis, early exposed, dark brown to blackish brown, 0.09–0.5 × 0.2–0.8 mm. Teliospores oblong to ellipsoid or narrowly obovoid, 1–3-celled, (12–)14–21(–25) × (29–)32–47 µm; wall 1.5–2 µm thick, cinnamon brown to chestnut brown but paler basally, smooth; apex truncate to rounded or conical, 4–8 (–10) µm thick; germ pore 1 per cell, obscure; pedicel hyaline to light brown, 4–8 × 15–32(–50) µm .

Material examined: On *Poa tibetica* Munro ex Stapf, with II and III stages, Pakistan, North West Frontier Province (NWFP), Nathia Gali, at 2545 m a. s. l., 12th October, 2007. NSA # B12. (LAH Herbarium No. NSA 1049).

Comments: From Pakistan, *Puccinia brachypodii* var. *poae-nemoralis* (G. H. Otth) Cummins & H. C. Greene and *P. poarum* have previously been reported on *Poa annua*, *P. nemoralis*, *P. pratensis* and *P. sterilis* from Lahore, Sharan, Swat



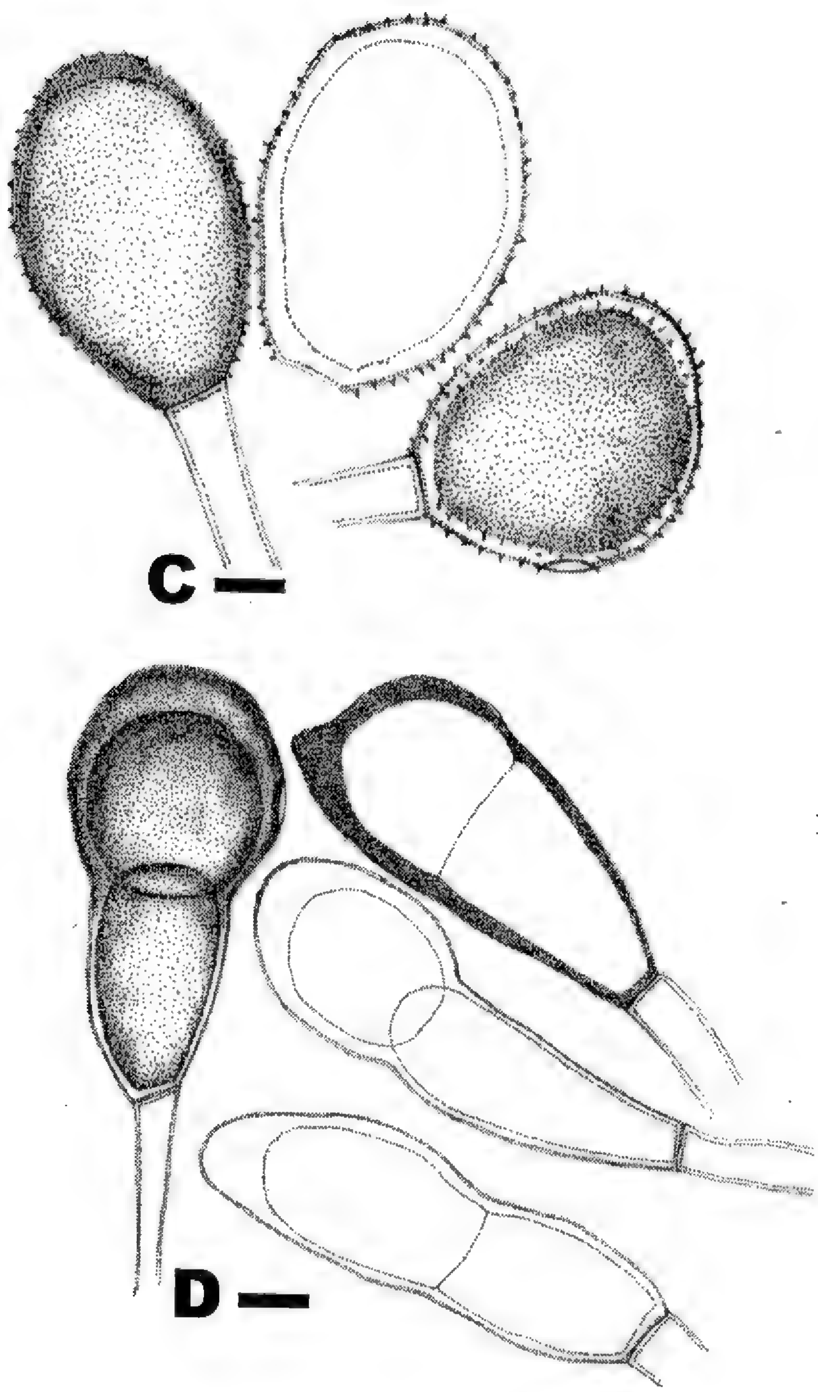
Figs. C–D: Lucida drawings of *Puccinia crandallii.*
C. Echinulated urediniospores. D. Teliospores.
Scale bar = 10 µm.

and AJK by Ahmad (1956a, b), Kakishima et al. (1993a, b) and Masood et al. (1995).

P. crandallii has previously been reported on species of *Poa* and *Festuca kingii* from the western United States (Cummins 1971). This rust is a new record for Pakistan and *Poa tibetica* is a new host for rust fungi of Pakistan.

Puccinia virgata Ellis & Everh.,
Proc. Acad. Nat. Sci. Philadelphia 1893: 154 (1893) (Figs. E–F)

Spermogonia and aecia unknown. Uredinia intermixed with telia, subepidermal, light brown to golden brown, 0.07–0.2 × 0.1–0.4 mm. Urediniospores ovoid to obovoid or ellipsoid to broadly ellipsoid, 21–28 × 26–36(–42) µm (mean 23.94 × 32.52 µm); wall 2–3 µm thick, light brown to dark brown, echinulate; apex up to 4 µm thick, germ pores 2–4, equatorial, pedicel



Figs. E–F: Lucida drawings of *Puccinia virgata*.
E. Urediniospores and paraphyses; F. Teliospores.
Scale bar = 10 µm.

hyaline, 7–9 µm wide and up to 35 µm long. PARAPHYSES cinnamon brown to chestnut brown, capitate, apex 14–17 µm wide, 7–9 µm thick at lower side, wall of apex up to 4 µm wide, up to 75 µm long. TELIA amphigenous, subepidermal, dark brown to blackish brown, 0.1–0.5 × 0.2–0.5 mm. TELIOSPORES clavate or ellipsoid, constricted at septa, upper cell rounded, lower cell elliptical; wall 1.5–2 µm thick, apex chestnut brown but paler basally, smooth; 16–24 × 37–54 µm (mean 19.75 × 45.98 µm); apex mostly rounded to slightly conical, 3–5 µm thick; germ pore 1 per cell, obscure; pedicel light brown to cinnamon brown, 8–9 × 14–18 µm.

MATERIAL EXAMINED: On *Panicum antidotale* Retz., with II and III stages, Pakistan, North West Frontier Province (NWFP), Bara Gali, at 2407 m a. s. l., 12th October, 2007. NSA # B15. (LAH Herbarium No. NSA 1101).

COMMENTS: Previously, *Uromyces superfluus* P. Syd. & Syd. has been reported on *Panicum antidotale* from Changa Manga and Karachi by Ahmad (1956a, b), Hasnain et al. (1959) and Ghaffar & Kafi (1968). This rust has been reported on species of *Erianthus* and *Sorghastrum* from United States to Mexico and Brazil (Cummins 1971). *Puccinia virgata* is a new record for Pakistan.

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The correct authorship of the genus *Hypomyces* and its original species

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Abstract — Historically, the abbreviation 'Tul.' was used indiscriminately to indicate authorship by L.-R. Tulasne as sole author and by L.-R. & C. Tulasne as joint authors. This ambiguity continues to result in misattribution of many names for which the author has previously been designated as 'Tul.', for example the genus *Hypomyces*. Linguistic analysis of numerous papers published by the Tulasne brothers confirms that they were joint authors of the protologue of the genus *Hypomyces* and its original 18 species. Therefore, using modern standard botanical author abbreviations, these names should be attributed to 'Tul. & C.Tul.', and not to 'Tul.'

Key words — nomenclature, Nees, Saccardo, Sydow, *Hypomyces lactifluorum*

Introduction

In the past, authors of taxonomic names have frequently been indicated by a miscellany of non-standardised—and often ambiguous—abbreviations. The publication of a comprehensive list of unambiguous standard botanical author abbreviations by Brummitt & Powell (1992) consolidated and expanded several previous partial lists, and the IPNI Authors website (IPNI 2009) continues to update the list. Nevertheless, there is still potential for error when the old ambiguous abbreviations are interpreted uncritically as if they were modern standard author abbreviations.

Old abbreviations that are particularly prone to misinterpretation are those in which the same abbreviation was used to indicate different family members, either singly or jointly. Four frequently encountered mycological examples (with modern standard author abbreviations in square brackets) are:

'Nees'—to indicate either Christian Nees von Esenbeck ['Nees'], or his brother Theodor Nees von Esenbeck ['T.Nees'], or both ['Nees & T.Nees'];

'Sacc.'—to indicate Pier Andrea Saccardo either alone ['Sacc.'] or with his son Domenico Saccardo as co-author ['Sacc. & D.Sacc.'];

'Syd.'—to indicate either Hans Sydow ['Syd.'], or his father Paul Sydow ['P.Syd.'], or both ['Syd. & P.Syd.' and 'P.Syd. & Syd.']; and

'Tul.'—to indicate Louis-René Tulasne either alone ['Tul.'] or with his brother Charles Tulasne as co-author ['Tul. & C.Tul.'].

The correct interpretation of each occurrence of such ambiguous abbreviations can be ascertained only by scrutiny of the original publication.

The authorship of the genus *Hypomyces* and its original species has long been subject to this type of misinterpretation. Kirk et al. (2001: 250; 2008: 334) and the Index Fungorum (2009), MycoBank (2009), and ING (2009) websites all cite the genus as '*Hypomyces* (Fr.) Tul. 1860' (or an equivalent). The *Hypomyces* protologue publication, Tulasne & Tulasne (1860), is sometimes correctly cited in websites and reference works, but more often miscited as 'Tulasne (1860)' [e.g., Lindau & Sydow (1909: 671) combined Tulasne (1860) and Tulasne & Tulasne (1860) into a single entry, as if they were duplicate publications by L.-R. Tulasne]; and the authorship of the type species, *H. lactifluorum*, and other species described in the protologue is variously attributed either to L.-R. Tulasne alone or to both Tulasne brothers. All of these problems stem from the indiscriminate use of the abbreviation 'Tul.' by the Tulasnes themselves, and by subsequent authors, to indicate authorship by either one or both of the brothers.

This publication combines evidence from the protologue and other literature published by the Tulasnes to establish the correct authorship of the genus and its 18 original species.

Authorship of the *Hypomyces* protologue

The name *Hypomyces* was raised to generic rank in Tulasne & Tulasne (1860). The title page of this paper cites the by-line: 'Par MM. Tulasne', indicating more than one Tulasne—the French honorific 'MM.' is an abbreviation for 'Messieurs', the plural of 'Monsieur' (abbreviation = 'M.'). Throughout the paper, and particularly in section II (in the French introduction and conclusion to the 6½ page Latin treatment of *Hypomyces*), the French first person plural pronoun 'nous' (= English 'we') is used repeatedly (see Table 1, bold entry). In the taxonomic treatments, fungal names attributable to the author(s) are indicated variously by '†', or 'Tul.', or 'Nob.'—the latter is an abbreviation of the Latin first person plural pronoun 'nobis' (= English '[according] to us').

However, a preliminary version of section I of Tulasne & Tulasne (1860) had been published several months previously in Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences de Paris (Tulasne 1860). This paper, by L.-R. Tulasne alone, provides some basis for speculation that Tulasne & Tulasne (1860) might also perhaps have been published by L.-R. Tulasne alone, with its

TABLE 1. Mycological papers published by the Tulasnes in Annales des Sciences Naturelles, Botanique, grouped and ordered according to the orthography of their by-lines. The French first person pronouns and the self-referring taxonomic author abbreviations/symbols used in each text are also indicated. The entry for the *Hypomyces* protologue paper (Tulasne & Tulasne 1860) is set in bold font; and an additional paper (Tulasne 1860), published in Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences de Paris, is included in italic font.

By-line orthography	Reference	Personal pronouns	Author abbreviations [1]
Papers by Louis-René Tulasne:			
L.R. Tulasne	Tulasne (1866)	[n.a.] [2]	Tul.
L.-R. Tulasne	Tulasne (1853c)	je / nous	†, N., Nob., Tul.
M. L.-R. Tulasne	Tulasne (1848)	je	—
M. L.-R. Tulasne	Tulasne (1851)	je	N.
M. L.-R. Tulasne	Tulasne (1852a)	je	†, Nob., Tul.
M. L.-R. Tulasne	Tulasne (1852b)	je	Tul.
M. L.-R. Tulasne	Tulasne (1853a)	je	—
M. L.-R. Tulasne	Tulasne (1853b)	je	†, N., Tul.
M. L.-R. Tulasne	Tulasne (1854)	je	†, Tul.
M. L.-R. Tulasne	Tulasne (1856a)	je / nous	Tul.
M. L.-R. Tulasne	Tulasne (1856b)	je	Tul.
M. L.-R. Tulasne	Tulasne (1857)	je	†
M. R.L. [sic] Tulasne	Tulasne (1865)	nous [3]	—
M. Tulasne	*Tulasne (1860)*	*je / nous* [3]	—
Papers by Louis-René & Charles Tulasne:			
L.R. et C. Tulasne	Tulasne & Tulasne (1841)	nous	N., Nob.
L.R. et Ch. Tulasne	Tulasne & Tulasne (1842a)	nous	—
L.-R. et Ch. Tulasne	Tulasne & Tulasne (1843)	nous	†, Nob.
L.-R. et Ch. Tulasne	Tulasne & Tulasne (1845a)	nous [4]	†, Tul.
MM. L.R. et C. Tulasne	Tulasne & Tulasne (1842b)	nous	—
MM. L.-R. et Ch. Tulasne	Tulasne & Tulasne (1844a)	nous	†, Nob.
MM. L.-R. et Ch. Tulasne	Tulasne & Tulasne (1844b)	nous	—
MM. L.-R. et Ch. Tulasne	Tulasne & Tulasne (1845b)	nous	†, Tul.
MM. L.-R. et Ch. Tulasne	Tulasne & Tulasne (1847)	nous	†, Nob.
MM. Tulasne	**Tulasne & Tulasne (1860)**	**nous**	**†, Nob., Tul.**
MM. Tulasne	Tulasne & Tulasne (1866)	nous	—
MM. Tulasne	Tulasne & Tulasne (1872)	nous	Tul.

[1] including the symbol '†'; and the abbreviations 'N.' or 'Nob.' (= Latin 'nobis').

[2] = not applicable (Latin text; no French).

[3] reporting activities undertaken jointly by the two brothers; e.g., "nous . . . mon frère et moi" (Tulasne 1860); "nous étions occupés de la rédaction de notre *Selecta Fungorum Carpologia*" (Tulasne 1865).

[4] in the French '*Obs.*' that follow the Latin text.

plural by-line honorific ‘MM.’ resulting from a typographic error, and its plural pronouns ‘nous’ and ‘nob.’ used as ‘the editorial “we”’ (‘pluralis editorialis’).

Linguistic evidence from Tulasne (1860)

The singular by-line of Tulasne (1860), ‘Par M. Tulasne’, indicates that the author was L.-R. Tulasne alone, but the text uses both singular and plural French pronouns, ‘je’ and ‘nous’ (see Table 1, italic entry). However, the context in which these pronouns are used suggests that ‘je’ represents the voice of the sole author making his presentation to the weekly Séance de l’Academie, whereas ‘nous’ refers to activities and ideas attributable jointly to the speaker and his brother (e.g., Tulasne 1860: 19, “nous . . . mon frère et moi”). Tulasne (1860) did not include any treatment of *Hypomyces*—that was first published in section II of Tulasne & Tulasne (1860).

Linguistic evidence from other Tulasne papers

Lindau & Sydow (1909) listed 25 mycological papers (including Tulasne & Tulasne 1860) published by one or both Tulasnes in the journal, Annales des Sciences Naturelles, Botanique. Two of these papers were written predominantly in Latin, and 23 predominantly in French. Table 1 gives an analysis of these papers, grouped and ordered according to the orthography of their by-lines.

French honorifics

Thirteen of the Annales papers had by-lines explicitly referring to L.-R. Tulasne alone; two of these by-lines did not include an honorific, and the other eleven included the singular honorific ‘M.’ Nine of the Annales papers had by-lines explicitly referring to both of the Tulasnes, four of them without an honorific and five with the plural honorific ‘MM.’ The remaining three papers (including Tulasne & Tulasne 1860) had the by-line ‘MM. Tulasne’, with the plural honorific indicating that they were written by both brothers.

French personal pronouns

All those Annales papers (including Tulasne & Tulasne 1860) with by-lines indicating joint publication by the two brothers consistently used the French first person plural pronoun ‘nous’ (Table 1, column 3). In contrast, all those Annales papers with by-lines indicating sole publication by L.-R. Tulasne used the French first person singular pronoun ‘je’ almost invariably; the very infrequent use of ‘nous’ in some of these papers can often be directly linked to contexts where the author was discussing activities undertaken jointly by the two brothers. It is clear that the Tulasnes used the French plural ‘nous’ literally and not as the editorial “we”.

Symbols and abbreviations denoting taxonomic authorship

The Annales papers used up to four different symbols/abbreviations to indicate taxonomic authorship by the Tulasnes. However, these variants apparently distinguish different categories of names: the symbol '†' indicates a newly described taxon (as stated explicitly in Tulasne & Tulasne 1843: 373); the abbreviations 'N.' and 'Nob.' (both = 'nobis') indicate a newly published comb. nov.; and the abbreviation 'Tul.' is confined to previously published names. Since 'N.' and 'Nob.' were used in papers written by L.-R. Tulasne alone as well as in papers written by both brothers (Table 1, Column 4), and since the equivalent Latin singular pronoun 'mihi' was not used in any of the papers, it is clear that the Latin plural 'nobis' was used as the editorial "we" in the single author papers.

Discussion

Analysis of the 25 Annales papers written by the Tulasnes indicates that those written by L.-R. Tulasne alone frequently included the singular honorific 'M.' in the by-line, and almost invariably used the French singular pronoun 'je'; whereas those written by both brothers frequently included the plural honorific 'MM.' in the by-line, and invariably used the French plural pronoun 'nous'. On this evidence, the *Hypomyces* protologue paper, Tulasne & Tulasne (1860), is confirmed as having been written by both brothers.

The correct citations for the genus *Hypomyces* and its original species are listed here, with their currently accepted teleomorph and anamorph names set in bold type. *Hypomyces* names that the Tulasnes applied to anamorphic fungi are labelled: [nom. anam.]. There are separate entries for the authentic taxon *H. luteovirens* and for "*H. luteovirens*" sensu Tul. & C.Tul. The interrogation mark in *Hypomyces? melanostigma* is a verbatim transcription from the protologue. The prefix ≡ indicates a homotypic synonym; = a heterotypic synonym; and ?= a tentative heterotypic synonym.

Hypomyces (Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 11. 1860.
[Tulasne & Tulasne 1865: 38.]
≡ *Hypocrea* subgen. *Hypomyces* Fr., Syst. Orbis Veg. 1: 105. 1825.

Hypomyces armeniacus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 12. 1860.
[Tulasne & Tulasne 1865: 41, sub *Hypomyces ochraceus*.]
?= *Hypomyces ochraceus* (Pers.) Tul. & C.Tul., Select. Fung. Carpol. 3: 41. 1865.
[uncertain application, fide Rogerson & Samuels 1995: 846.]
anam.: *Acremonium verticillatum* Link : Fr., Ges. Naturf. Freunde Berlin Mag. 3: 15. 1809.
≡ *Mycogone verticillata* (Link : Fr.) Spreng., Syst. Veg. 4(1): 555. 1827.
≡ ***Cladobotryum verticillatum*** (Link : Fr.) S. Hughes, Can. J. Bot. 36: 750. 1958.
[fide Rogerson & Samuels 1995: 843.]

Hypomyces asterophorus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 14. 1860. [Tulasne & Tulasne 1865: 54.]
≡ *Pyxidiophora nyctalidis* Bref. & Tavel, Unters. Gesammtgeb. Mykol. 10: 189. 1891, nom. nov. superfl.
≡ ***Pyxidiophora asterophora*** (Tul. & C.Tul.) Lindau, Nat. Pflanzenfam. 1(1): 351. 1897.

anam.: *Polyscytalum fungorum* Sacc., Syll. Fung. 4: 336. 1886.
≡ ***Chalara brefeldii*** Lindau, Rabenh. Krypt.-Fl. Ed. 2, 1(8): 750. 1906 ['1907'], nom. nov. [fide Lindqvist 1980: 136.]

Hypomyces aurantius (Pers. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 12. 1860. [Tulasne & Tulasne 1865: 43, in comments sub *Hypomyces ochraceus*.]
≡ *Sphaeria aurantia* Pers. : Fr., Icon. Descr. Fung. 2: 45. 1800.
≡ *Nectria aurantia* (Pers. : Fr.) Fr., Sum. Veg. Scand.: 388. 1849.
≡ *Bonordenia aurantia* (Pers. : Fr.) Schulzer, Verh. K. K. Zool.-Bot. Ges. Wien 16: 58. 1866.
≡ *Hypolyssus aurantius* (Pers. : Fr.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.

anam.: ***Cladobotryum varium*** Nees : Fr., Syst. Pilze: 56. 1816–17. [fide Rogerson & Samuels 1993: 245.]
≡ *Dactylium macrosporum* [?subsp.] *varium* (Nees : Fr.) Fr., Syst. Mycol. 3(2): 414. 1832, as '*D. macrosporum* * *D. varium*'.
≡ *Dactylium varium* (Nees : Fr.) Fr., Syst. Mycol. 3(Index): 81. 1832.

Hypomyces australis (Mont.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 12. 1860.
≡ *Nectria australis* Mont., in Gay, Hist. Fis. Pol. Chile 7: 455. 1854.
≡ *Byssonectria australis* (Mont.) Berk. & Broome, Grevillea 12: 109. 1884.
≡ *Cucurbitaria australis* (Mont.) Kuntze, Revis. Gen. Pl. 3(3): 460. 1898.

anam.: ***Cladobotryum* sp.** [fide Rogerson & Samuels 1993: 247.]

Hypomyces baryanus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 13. 1860. [nom. anam.] [Tulasne & Tulasne 1865: 59.]
≡ *Hypolyssus baryanus* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ ***Ugola baryana*** (Tul. & C.Tul.) Redhead & Seifert, Taxon 50(1): 250. 2001 ['2000'].

teleom.: *Agaricus parasiticus* Bull. ex Pers. : Fr., Syn. Meth. Fung.: 371. 1801.
≡ *Nyctalis parasitica* (Bull. ex Pers. : Fr.) Fr., Epicr. Syst. Mycol.: 372. 1838.
≡ ***Asterophora parasitica*** (Bull. ex Pers. : Fr.) Singer, Lilloa 22: 171. 1951 ['1949'].

Hypomyces cervinus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 16. 1860. [nom. anam.] [Tulasne & Tulasne 1865: 51.]
≡ *Hypolyssus cervinus* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.

= ***Mycogone cervina*** Ditmar : Fr., Deutschl. Fl., 3. Abt., 1(4): 107. 1817. [fide Saccardo 1883: 477.]
≡ *Sepedonium cervinum* (Ditmar : Fr.) Fr., Syst. Mycol. 3(2): 439. 1832.
≡ *Mycobanche cervina* (Ditmar : Fr.) Wallr., Fl. Crypt. Germ. 2: 273. 1833.

teleom.: ***Hypomyces cervinigenus*** Rogerson & Simms, Mycologia 63: 418. 1971.

Hypomyces chlorinus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 13. 1860. [nom. anam.] [Tulasne & Tulasne 1865: 59.]
≡ *Hypolyssus chlorinus* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ ***Sepedonium chlorinum*** (Tul. & C.Tul.) Damon, Mycologia 44: 95. 1952.
≡ *Leiosepium chlorinum* (Tul. & C.Tul.) A.Fontana, Allionia 9: 135. 1963, as '*Lejosepium*'.
teleom.: ***Hypomyces chlorinigenus*** Rogerson & Samuels, Mycologia 81: 423. 1989.

Hypomyces chrysospermus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 16. 1860. [Tulasne & Tulasne 1865: 49.]
≡ *Hypolyssus chrysospermus* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ *Apiocrea chrysosperma* (Tul. & C.Tul.) Syd. & P.Syd., Ann. Mycol. 18: 187. 1921 ['1920'].
anam.: *Reticularia chrysosperma* Bull. : Fr., Herb. France 10: t.476 f.4. 1790.
≡ *Mucor chrysospermus* (Bull. : Fr.) Bull., Hist. Champ. France 1: 99. 1791.
≡ *Mycobanche chrysosperma* (Bull. : Fr.) Pers., Traité Champ. Comest.: 133. 1818.
≡ ***Sepedonium chrysospermum*** (Bull. : Fr.) Fr., Syst. Mycol. 3(2): 438. 1832. [fide Rogerson & Samuels 1989: 428.]

Hypomyces hyalinus (Schwein. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 11. 1860. [Tulasne & Tulasne 1865: 63, as *Sphaeria hyalina*, in comments sub *Hypomyces lateritius*.]
≡ *Sphaeria hyalina* Schwein. : Fr., Schrift. Naturf. Ges. Leipzig 1: 30. 1822.
≡ *Hypocrea hyalina* (Schwein. : Fr.) Fr., Sum. Veg. Scand.: 383. 1849.
≡ *Peckiella hyalina* (Schwein. : Fr.) Sacc., Syll. Fung. 9: 945. 1891.
≡ *Hypolyssus hyalinus* (Schwein. : Fr.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ *Apiocrea hyalina* (Schwein. : Fr.) Syd. & P.Syd., Ann. Mycol. 18: 187. 1921 ['1920'].

Hypomyces lactifluorum (Schwein. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 11. 1860. [type species; Seaver 1910: 71] [Tulasne & Tulasne 1865: 63, in comments sub *Hypomyces lateritius*.]
≡ *Sphaeria lactifluorum* Schwein. : Fr., Schrift. Naturf. Ges. Leipzig 1: 30. 1822.
≡ *Hypolyssus lactifluorum* (Schwein. : Fr.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.

Hypomyces lateritius (Fr. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 11. 1860. [Tulasne & Tulasne 1865: 62.]
≡ *Sphaeria lateritia* Fr. : Fr., Mykologische Hefte 2: 42. 1823.
≡ *Hypocrea lateritia* (Fr. : Fr.) Fr., Sum. Veg. Scand.: 383. 1849.
≡ *Peckiella lateritia* (Fr. : Fr.) Maire, Ann. Mycol. 4: 331. 1906.
≡ *Byssonectria lateritia* (Fr. : Fr.) Petch, J. Bot. 75: 220. 1937.
anam.: ***Acremonium tulasnei*** G.R.W.Arnold, Nov. Sist. Niz. Rast. 8: 129. 1971.
≡ *Cladobotryum tulasnei* (G.R.W.Arnold) Helfer, Libri Bot. 1: 36. 1991.

Hypomyces linkii Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 16. 1860. [nom. anam.] [Tulasne & Tulasne 1865: 44.]
≡ *Hypolyssus linkii* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
= ***Mycogone rosea*** Link : Fr., Ges. Naturf. Freunde Berlin Mag. 3: 18. 1809. [fide Saccardo 1883: 477.]

≡ *Mycogone incarnata* var. *rosea* (Link) Pers., Mycol. Eur. 1: 26. 1822.
≡ *Sepedonium roseum* (Link : Fr.) Fr., Syst. Mycol. 3(2): 438. 1832.
≡ *Mycobanche rosea* (Link : Fr.) Wallr., Fl. Crypt. Germ. 2: 273. 1833.

Hypomyces luteovirens (Fr. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 13. 1860. [agaricicolous; non sensu Tul. & C.Tul. (= *Hypomyces tulasneanus*)]
≡ *Sphaeria luteovirens* Fr. : Fr., Kongl. Vetensk. Acad. Handl. 38: 251. 1817.
≡ *Hypocrea luteovirens* (Fr. : Fr.) Fr., Sum. Veg. Scand.: 383. 1849.
≡ *Peckiella luteovirens* (Fr. : Fr.) Maire, Ann. Mycol. 9: 318. 1911.
≡ *Byssonectria luteovirens* (Fr. : Fr.) Z.Moravec, Česká Mykol. 10: 87. 1956.

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= ***Hypomyces tulasneanus*** Plowr., Grevillea 11: 46. 1882.
≡ *Peckiella tulasneana* (Plowr.) Sacc., Syll. Fung. 9: 944. 1891.
≡ *Hypolyssus tulasneanus* (Plowr.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ *Apiocrea tulasneana* (Plowr.) Syd. & P.Syd., Ann. Mycol. 18: 187. 1921 ['1920'].

anam.: ***Sepedonium tulasneanum*** Sacc., Syll. Fung. 4: 148. 1886. [fide Rogerson & Samuels 1989: 430.]
≡ *Leiosepium tulasneanum* (Sacc.) G.R.W.Arnold, Westfäl. Pilzbriefe 7(5): 81. 1969, as '*Lejosepium*'.

Hypomyces? melanostigma Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 17. 1860. [Tulasne & Tulasne 1865: 56, in comments sub *Hypomyces asterophorus*.]
≡ *Hypolyssus melanostigma* (Tul. & C.Tul.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
?= ***Hypomyces asterophorus*** Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 14. 1860. [fide Saccardo 1883: 467.]

Hypomyces pezizae (Corda) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 16. 1860. [nom. anam.] [Tulasne & Tulasne 1865: 52.]
≡ *Asterophora pezizae* Corda, Icon. Fung. 6: 3. 1854.
= ***Stephanoma strigosum*** Wallr., Fl. Crypt. Germ. 2: 269. 1833. [fide Rogerson & Samuels 1985: 775.]

teleom.: ***Hypomyces stephanomatis*** Rogerson & Samuels, Mycologia 77: 775. 1985.

Hypomyces rosellus (Alb. & Schwein. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 12. 1860. [Tulasne & Tulasne 1865: 45.]
≡ *Sphaeria rosella* Alb. & Schwein. : Fr., Consp. Fung. Lusat.: 35. 1805.
≡ *Nectria rosella* (Alb. & Schwein. : Fr.) Fr., Summa Veg. Scand.: 388. 1849.

anam.: *Mucor dendroides* ***Bull. : Fr., Hist. Champ. France 1: 105. 1791.***
≡ *Botrytis dendroides* (Bull. : Fr.) DC., Fl. Franç. 2: 70. 1805.
≡ *Dactylium dendroides* (Bull. : Fr.) Fr., Syst. Mycol. 3(2): 414. 1832.
≡ ***Cladobotryum dendroides*** (Bull. : Fr.) W.Gams & Hooz., Persoonia 6: 103. 1970. [fide Rogerson & Samuels 1993: 258.]

Hypomyces ternatus Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 16. 1860. [Tulasne & Tulasne 1865: 47, in comments sub *Hypomyces rosellus*.]
?= ***Hypomyces aurantius*** (Pers. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 12. 1860.

anam.: *Cladotrichum ternatum* ***Bonord., Handb.: 78, 1851.***
≡ *Didymocladium ternatum* (Bonord.) Sacc., Syll. Fung. 4: 187. 1886.
?= ***Cladobotryum varium*** Nees : Fr., Syst. Pilze: 56. 1816–17.
[fide Gams & Hoozemans 1970: 100.]

Hypomyces violaceus (J.C.Schmidt ex Fr. : Fr.) Tul. & C.Tul., Ann. Sci. Nat., Bot., 4e Sér., 13: 14. 1860. [Tulasne & Tulasne 1865: 60.]
≡ *Sphaeria violacea* J.C.Schmidt ex Fr. : Fr., Syst. Mycol. 2(2): 441. 1823.
≡ *Nectria violacea* (J.C. Schmidt ex Fr. : Fr.) Fr., Summa Veg. Scand.: 388. 1849.
≡ *Peckiella violacea* (J.C. Schmidt ex Fr. : Fr.) Sacc., Syll. Fung. 9: 945. 1891.
≡ *Hypolyssus violaceus* (J.C. Schmidt ex Fr. : Fr.) Kuntze, Revis. Gen. Pl. 3(3): 488. 1898.
≡ *Byssonectria violacea* (J.C. Schmidt ex Fr. : Fr.) Seaver, Mycologia 2(2): 65. 1910.
≡ ***Nectriopsis violacea*** (J.C.Schmidt ex Fr. : Fr.) Maire, Ann. Mycol. 9: 323. 1911.
≡ *Hyphonectria violacea* (J.C. Schmidt ex Fr. : Fr.) Petch, J. Bot. 75: 220. 1937.

anam.: *Diplosporium album* **var.** *fungicola* Sacc., Syll. Fung. 4: 178. 1886.
≡ ***Acremonium fungicola*** (Sacc.) Samuels, Mycologia 65: 404. 1973.

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Tulasne L-R. 1851. Note sur l'appareil reproducteur dans les lichens et les champignons. Annales des Sciences Naturelles, Botanique, 3e Série, 15: 370–382.

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Tulasne L-R. 1853b. Mémoire sur l'*Ergot* des Glumacées. Annales des Sciences Naturelles, Botanique, 3e Série, 20: 5–56.

Tulasne L-R. 1853c. Nouvelles recherches sur l'appareil reproducteur des champignons. Annales des Sciences Naturelles, Botanique, 3e Série, 20: 129–182.

Tulasne L-R. 1854. Second mémoire sur les Urédinées et les Ustilaginées. Annales des Sciences Naturelles, Botanique, 4e Série, 2: 77–196.

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Tulasne L-R. 1857. Note sur les *Isaria* et *Sphaeria* entomogènes. Annales des Sciences Naturelles, Botanique, 4e Série, 8: 35–43.

Tulasne L-R. 1860. De quelques Sphéries fongicoles, à propos d'un récent mémoire de M. Ant. de Bary sur les *Nyctalis*. Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences de Paris 50: 16–19.

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A new species of *Hyphoderma* (*Basidiomycetes*) from India

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Abstract – A new corticioid species, *Hyphoderma singularibasidium*, is described from Dalhausie hills in Himachal Pradesh.

Key words – Chamba, peculiar basidial outgrowth

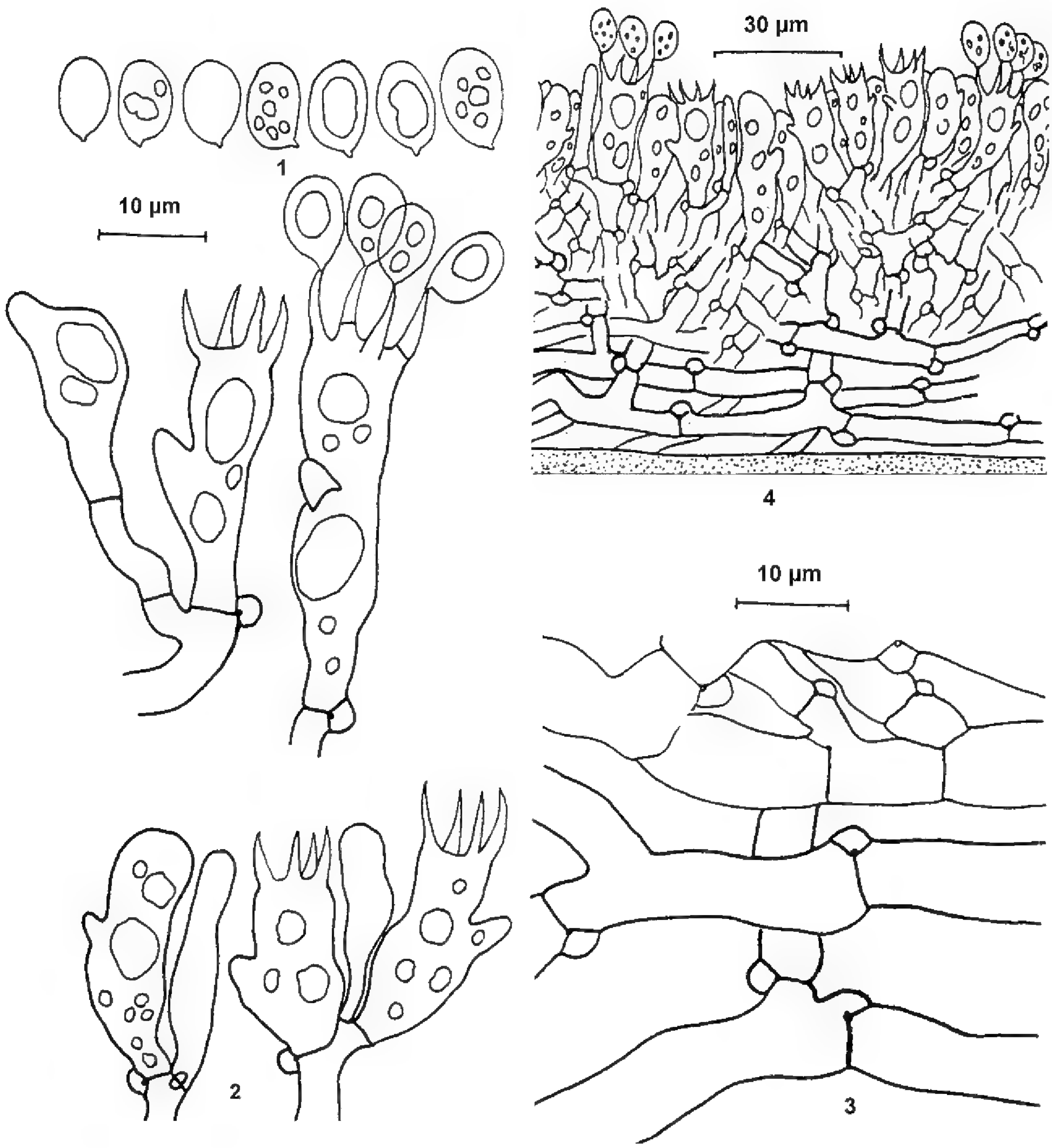
During the fungal forays conducted in the Banikhet area of Dalhausie hills in district Chamba of Himachal Pradesh, India, Dhingra & Singla made a collection on the underside of a decayed gymnospermous log. After detailed macroscopic and microscopic comparisons with descriptions of known species of genus *Hyphoderma* (Eriksson & Ryvarden 1975, Rattan 1977, Dhingra 1989) we found it to belong to this genus but representing a species of its own. Typical characters of the genus are large sized, clavate, somewhat constricted, 4-spored basidia and ellipsoid basidiospores with oily contents. However, wide- and short-celled subhymenial hyphae, basidia with a peculiar outgrowth arising from the middle of the basidium, and broadly ellipsoid basidiospores suggest that the collection represents a new species. A sample of the basidiocarp was sent to Prof. Nils Hallenberg, University of Göteborg, Sweden, who also supported the concept of a new species in genus *Hyphoderma*.

Hyphoderma singularibasidium Dhingra, Avneet P. Singh & Singla, **sp. nov.**
MycoBank MB508857 Figs 1–5

Basidiocarpi resupinati, laxe adnati, exilies, usque ad 120 μm crassa; superficies hymenialis rugulosa, minute farinacea, ravidoalba-flavidoalba; systema hyphale monomiticum; hyphae usque ad 8 μm latas, tenuitunicataepaulo crassitunicatae, nodoso septatae; basidia 17–35 × 7.0–9.1 μm, clavata-subclavata, colligata, cum processu peculiari medioenato, 4-sterigmata, ad basin fibuligera; basidiospori 7.4–9.1 × 4.5–5.7 μm, late ellipsoidei, laeves, tenuitunicati.

Holotypus: *Himachal Pradesh: Chamba, Banikhet, istorsum Surkhigala, in lingo putrido Cedri deodarae, Nishi 1397 (PUN) September 23, 1989.*

Etymology: On the basis of a peculiar lateral outgrowth on basidia.



FIGS 1–4. Microscopic structures from basidiocarp of *Hyphoderma singularibasidium*. 1. basidiospores; 2. basidia; 3. generative hyphae; 4. vertical section of the basidiocarp.

Basidiocarps resupinate, loosely adnate, thin, up to 120 µm thick in section; hymenial surface rough, farinaceous under the lens, grayish white to yellowish white; margins indeterminately thinning out. Hyphal system monomitic; generative hyphae up to 8 µm wide, thin- to somewhat thick-walled, clamped; basal hyphae running parallel to the substrate, less branched, with large cells; subhymenial hyphae much branched, branches arising from the clamps. Basidia 17–35 × 7.0–9.1 µm, clavate to subclavate but constricted in the middle, thin-walled, with a peculiar unilateral outgrowth arising from the middle of the basidium, 4-sterigmate, with a basal clamp, with oily contents; sterigmata up

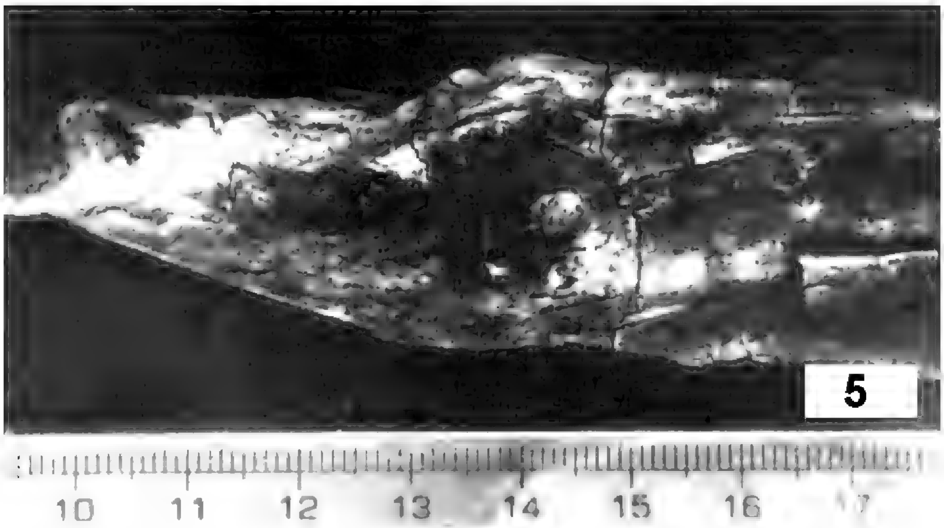


FIG. 5. *Hyphoderma singularibasidium* basidiocarp showing hymenial surface.

to 7.4 µm long. Basidiospores 7.4–9.1 × 4.5–5.7 µm, broadly ellipsoid, thin- to somewhat thick-walled, smooth, inamyloid, acyanophilous, with a large oil drop or many smaller oil droplets.

The lateral outgrowth from the middle of basidium, pointing in apical direction is a unique character among corticoid *Basidiomycetes*, not reported earlier.

Acknowledgements

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The first record of *Dimargaris bacillispora* (*Dimargaritales*) in South America

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Abstract – *Dimargaris bacillispora* was reported for the first time in South America from tapir (*Tapirus terrestris*) dung collected at the Reserva Ecológica de Dois Irmãos (8°7'30" S and 34°52'30" W), located in Recife, State of Pernambuco, Northeast Brazil.

Key Words – *Zygomycetes*, *Dimargaritaceae*, herbivore, taxonomy

Introduction

The first report of *Dimargaris* was provided by Tieghem (1875), who introduced the genus and described *Dimargaris cristalligena* from rat dung in Paris, France. Subsequently, valuable contributions were provided by Benjamin (1959, 1965), Mehrotra & Baijal (1963, 1964), Boedijn (1959), Mikawa (1976), Mirza et al. (1979), Kirk & Kirk (1984) and Wrzosek & Gajowniczek (1998). Currently, *D. arida*, *D. bacillispora*, *D. cristalligena*, *D. oblongispora*, *D. simplex*, *D. verticillata* and *D. xerosporica* are recognized in the genus (Benny 2005).

Dimargaris bacillispora was first described by Benjamin (1959) from mouse dung in California (USA). Since then only a few records of this species have been published. *Dimargaris bacillispora* is a parasite of *Mortierellales* and *Mucorales* (Benny 2005), as the other species of the genus.

The aim of this report is the description of *D. bacillispora* from tapir dung in Brazil.

Materials and methods

Samples of tapir (*Tapirus terrestris* L.) dung were collected at the Reserva Ecológica de Dois Irmãos (8°7'30"S and 34°52'30"W), which includes a

Zoological Park, located in Recife, State of Pernambuco, Northeast of Brazil. The area is 387 ha and comprises an Atlantic Forest Ecological Reserve. The samples were collected with a sterilized spatula, placed in plastic bags, taken to the laboratory and incubated in a moist chamber at 28°C ± 2°C for 7 days under alternating light and dark periods. The specimen was studied directly from the substrata under a stereomicroscope and a light microscope and described according to Benjamin (1959). A slide is deposited in the Pe. Camille Torrend (URM) Herbarium of the Universidade Federal de Pernambuco, Recife, Brazil.

Taxonomy

Dimargaris bacillispora R.K. Benj., Aliso 4: 376 (1959) FIG. 1 A–D

MATERIAL EXAMINED: Brazil, Pernambuco, Recife, Reserva Ecológica de Dois Irmãos, May/06, A. L. C. M. A. Santiago (URM 80036/46015).

SPOROPHORES erect, colorless, 1–3 mm long, with simple branches, that become irregularly verticillate, bearing fertile heads terminally. SEPTUM with a lenticular cavity. FERTILE BRANCHES 50–400 × 6·5–12 µm, formed below each of the distal septa of the main stalks and producing one or two secondary branches. DISTAL CELLS of the main stalks about 100–200 µm long. BASAL CELLS of the main stalks 7·5–13 µm wide. FERTILE HEADS 30–60 µm diam, composed of four divergent sporiferous branchlets bearing cells formed successively by budding. BASAL CELLS 10–18 × 7·5–10 µm; cells of the primary branches producing 1–3 divergent cells which may form new cells that produce merosporangia or give rise to merosporangia. All cells of sporiferous heads, except a few of the proximal cells of the primary and secondary branches, disarticulating at maturity and the spores, immersed in drops of liquid which form glistening white spheres about 22–45 µm diam. MEROSPORANGIA cylindrical, simultaneously forming two bacilliform slightly curved MEROSPORES, 5–6(–7·5) × 1·5–2·5 µm, with a globule at each end. ZYGOSPORES not observed.

HABITAT: Parasitizing *Mucor* sp. growing on tapir dung.

DISTRIBUTION: Brazil, Mexico, Pakistan, USA (California, Florida, Arizona).

NOTES: The characteristics of this strain of *D. bacillispora* showed a close similarity with the description of Benjamin (1959), except for the merospores, which have a globule at each end. However, we do not consider this difference enough to characterize a new variety.

Mehrotra & Baijal (1963) reported an isolate of *Dimargaris* from cow dung in Allahabad, India and named it *D. oblongispora*. According to these authors, this species is closely related to *D. bacillispora* and differs in producing oblong merospores and sporangiophores with septate branches. However, according to Kirk & Kirk (1984), this isolate from India does not appear, from the published description and illustrations, to be significantly different from *D. bacillispora*,

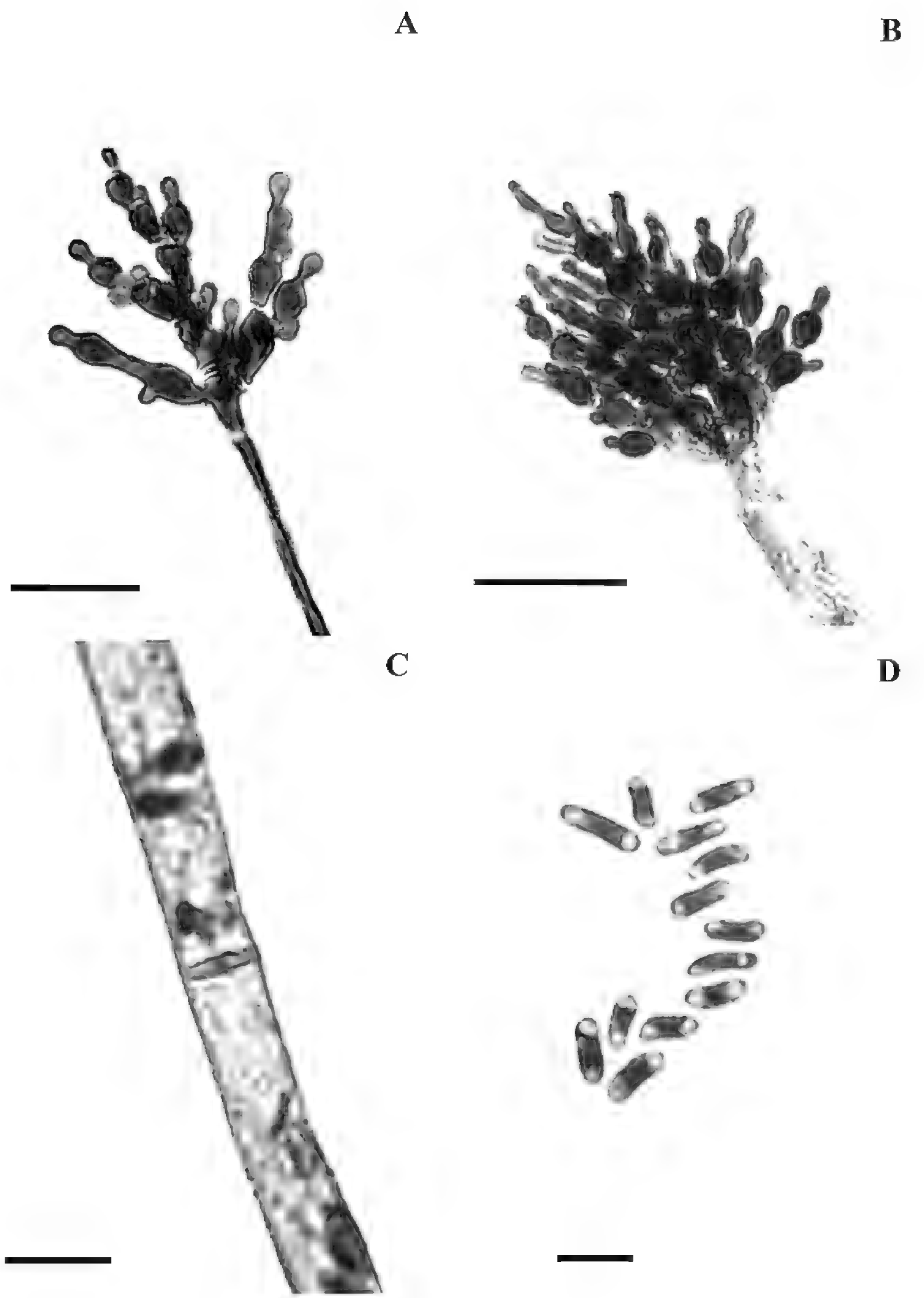

Fig 1. *Dimargaris bacillispora*
A, B. Sporophores and fertile heads in different stages of development;
C. Septum with a lenticular cavity; D. Sporangiospores.
Scale bars: A–B = 25µm; C = 10µm; D = 5µm.

and these two species should probably be placed in synonymy. Nevertheless, these two species were listed by Benny (2005) and in Species Fungorum (www.speciesfungorum.org) as being distinct.

This report describes the first occurrence of *Dimargaris* in South America, contributing to the knowledge of the geographical distribution of *Dimargaritales*. Only one taxon from this order has been reported previously in Brazil, *Dispira cornuta* isolated from herbivore dung (Viritato & Trufem 1985).

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Stemonaria fuscoides (*Stemonitaceae, Myxomycetes*): a new record for Brazil

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Abstract — Studies are being carried out in Brazilian mangroves with the aim of contributing to the knowledge of myxomycetes from ecosystems associated with the Atlantic forest. A total of 330 moist chamber cultures were prepared with aerial litter, ground litter, tree bark, and small woody twigs of *Conocarpus erectus* (*Combretaceae*), *Rhizophora mangle* (*Rhizophoraceae*), and *Acrostichum aureum* (*Polypodiaceae*). Four specimens of *Stemonaria fuscoides* were obtained from the cultures prepared with *R. mangle* and *C. erectus*. Previously, *Stemonaria* was represented in Brazil only by *S. longa*, cited for the North (Amazonas State), Northeast (Bahia, Pernambuco, Ceará and Piauí States), Southeast (Rio de Janeiro and São Paulo States), and South (Paraná State), and *S. irregularis*, cited for the states of Ceará and Pernambuco. *Stemonaria fuscoides* is recorded for the first time for the Neotropics and in a mangrove environment.

Key words — *Stemonitales*, taxonomy, myxobiota

Introduction

The family *Stemonitaceae* includes 16 genera, of which *Stemonitis* Gled. and *Comatricha* Preuss are cited most often in the literature. *Stemonaria* Nann.-Bremek. et al. was proposed to accommodate those species in the family that were not well placed in *Stemonitis*, *Comatricha*, *Stemonitopsis* (Nann.-Bremek.) Nann.-Bremek., or *Symphytocarpus* Ing. & Nann.-Bremek., despite having some characteristics in common with these genera (Nannenga-Bremekamp et al. 1984).

Species of *Stemonaria* differ from those placed in the genus *Comatricha* because of the longitudinally rigid, fibrous, or homogeneous construction of the

stipe and columella. *Stemonaria* species can be distinguished from *Stemonitis* due to the absence of a peripheral capillitial net, from *Stemonitopsis* because of the above mentioned structures and absence of a partial peripheral capillitial net, and from *Symphytocarpus* because they are distinctly stipitate and do not form pseudoaethalia (Nannenga-Bremekamp et al. 1984). When proposing the new taxa, Nannenga-Bremekamp et al. (1984) created a key with the aim of aiding in the identification of the species classified as *Stemonaria*. Of the nine species treated, six were described as new to science and three — *Comatricha irregularis* Rex, *Comatricha nannengae* T. N. Lakh. & Mukerji, *Comatricha longa* Peck — were transferred from *Comatricha* because they did not have a fibrous stipe. Between 1987 and 1995, the same authors described five new *Stemonaria* species, four from Japan and another (*S. argentella* Y. Yamam.) from Nepal.

The 14 species that presently comprise the genus have known distributional patterns for both hemispheres, and *Stemonaria longa* (Peck) Nann.-Bremek. et al., *S. irregularis* (Rex) Nann.-Bremek. et al., and *S. gracilis* Nann.-Bremek. & Y. Yamam. have been reported previously for the Neotropics (Farr 1976, Lado 2001, Hernández-Crespo & Lado 2005, Basanta et al. 2008, Lado & Basanta 2008).

Stemonaria irregularis and *S. longa* are a known part of the Brazilian myxomycete biota. The former is known only from the northeastern region and the latter has been reported from several different regions of the country (Cavalcanti 2002, Maimoni-Rodella 2002, Putzke 2002). This paper reports *S. fuscoides* Nann.-Brem. & Y. Yamam. for the first time for Brazil, where it was found associated with substrates derived from two species of mangroves on the southern coast of the state of Pernambuco.

Materials and methods

Samples of the litter and bark of living *Rhizophora mangle* L. (*Rhizophoraceae*) trees were collected from the Nossa Senhora do Ó mangrove forest, located in the municipality of Ipojuca (8° 24'S and 35° 03' 45"W), 50.2 km south of the city of Recife, Pernambuco. Part of the Ipojuca River drainage basin, this area has a hot and humid climate, an average annual temperature of 26.1°C, and Atlantic Forest vegetation, with its associated ecosystems, mangroves and restingas, a typical formation that occurs in Brazilian coast (CPMR/FIDEM 1998, CONDEPE/FIDEM 2005).

The municipality of Rio Formoso (8° 37'–8° 41'S and 35° 04'–35° 08' W) is 76 km south of Recife and approximately 4 km north of Tamandaré Bay (Lira & Fonseca 1980, FIDEM 1987). Samples of *Acrostichum aureum* L. (*Polypodiaceae*) fronds and aerial litter, ground litter, bark of living trees and small woody twigs of *Conocarpus erectus* L. (*Combretaceae*) were collected from the mangrove

forest located in the Formoso River estuary, which is 12 km long and is formed by contributions of the Formoso, dos Passos, Lemenho, and Ariquindá rivers.

The substrates obtained were used to prepare 330 moist chamber cultures (Novozhilov et al. 2000), which were kept at room temperature and under diffuse light conditions; the cultures were observed weekly during three consecutive months in order to record the presence of myxomycete plasmodia and/or sporocarps. After being stored for 16 months and 24 days, 141 of the cultures prepared with Nossa Senhora do Ó mangrove substrates were once again hydrated and observed for another three months.

The *Stemonaria* sporocarps obtained from these cultures were analyzed, and identified (Farr 1976, Nannenga-Bremekamp et al. 1984) and the collections were deposited in the UFP herbarium (Recife-PE) under numbers 50.314, 50.318, 50.326, and 50.563.

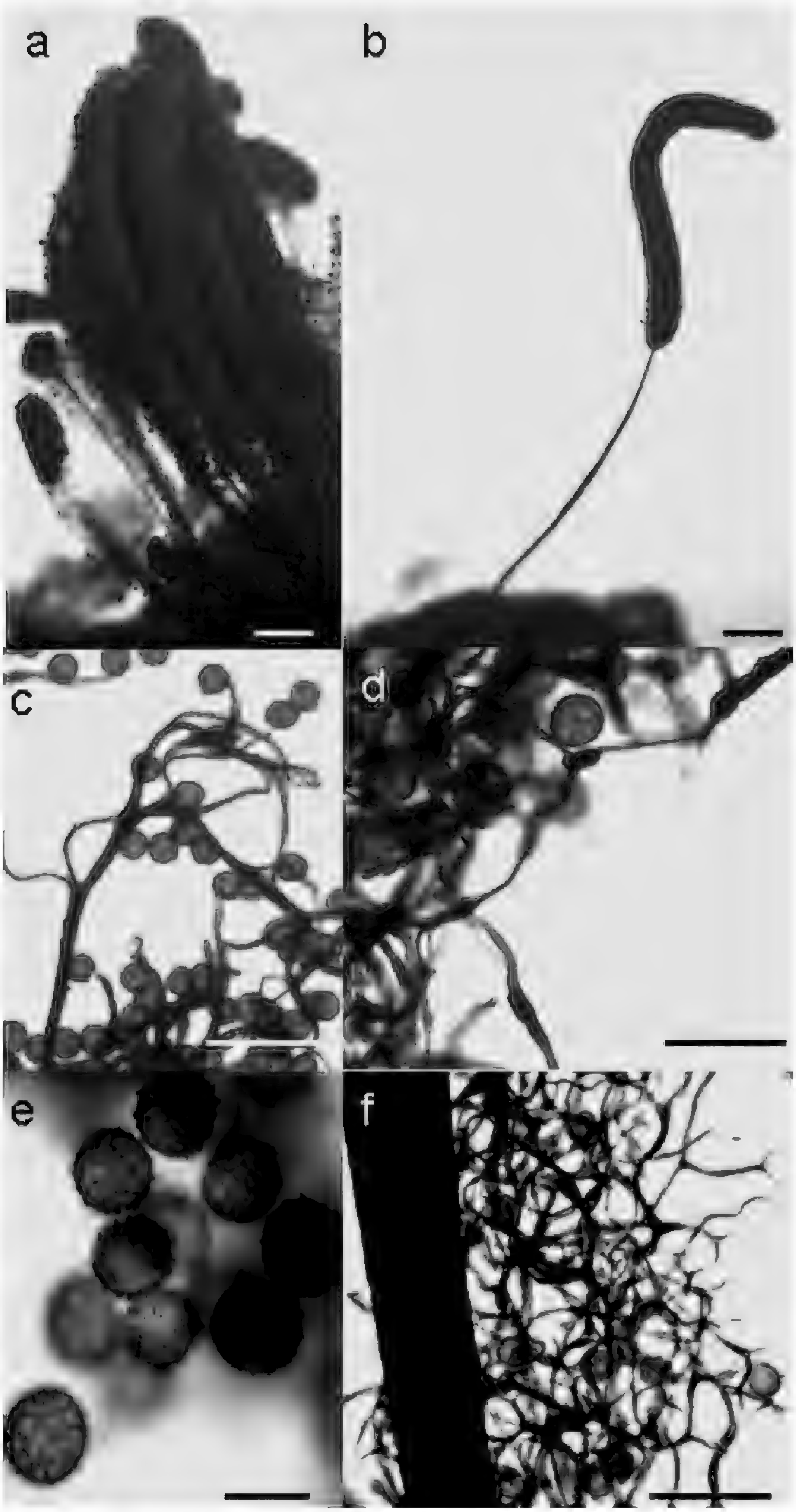
Results and discussion

Half (50.35%) of the moist chamber cultures prepared with N. S. do Ó mangrove material were positive, and three of those containing the bark of living *R. mangle* trees as a substrate produced *Stemonaria* sporangia, which were distributed in groups in one of them and sparsely in the other two. Similar sporangia were also observed in one of the 112 positive cultures prepared with substrates from the Rio Formoso mangrove forest after seven months.

The sporangia, which are linked by a common brilliant, dark brown hypothallus, are 1.7–4.5 mm in total height and have cylindrical, reddish brown stipes (Fig. 1a–b). The sporothecae are cylindrical, brown, 0.2–0.3 mm in diameter, and each has a subcylindrical columella that narrows as it approaches the apex, close to which it splits into two branches (Fig. 1b–c). The capillitium is brown and its filaments have several dark brown expansions characterized by the presence of bulbs or nodules (Fig. 1d & f) that are anastomosed but do not form a net. The spores are pale brown, 9–10 µm in diameter, and ornamented by spines that form complete reticulation in at least one of the hemispheres (Fig. 1d–e).

When comparing the characteristics of the mangrove specimens with the description of *S. fuscoides* presented by Nannenga-Bremekamp et al. (1984), there are differences only with respect to the slightly smaller total height and diameter of the sporocarps and stipe, with the remaining characters typical of the species.

The sporocarps of the collection incubated in the moist chambers prepared using litter from the Rio Formoso mangrove forest have all of the characteristics of var. *longipes* (Fig. 1b) as described by Yamamoto & Nannenga-Bremekamp (1995). They differ from the type variety only in the stalk length, which reaches up to 50% of the total sporocarp height.


a
b
c
d
e
f

Until now, the genus *Stemonaria* was represented in Brazil only by *S. longa* (as *Comatricha longa*) for the North (Amazonas), Northeast (Bahia, Pernambuco, Ceará, Piauí), Southeast (Rio de Janeiro, São Paulo), and South (Paraná) and by *S. irregularis* (as *Comatricha irregularis*) for the states of Ceará and Pernambuco (Torrend 1915, 1916; Farr 1960; Cavalcanti 1976, 2002; Gottsberger et al. 1992; Hochgesand & Gottsberger 1996; Putzke 1996, 2002; Cavalcanti & Putzke 1998; Mobin & Cavalcanti 1999; Maimoni-Rodella 2002). *Stemonaria longa* was found both in urban environments and in humid forests of the northern, northeastern, and southern parts of the country, while *S. irregularis* has been recorded only for humid forest environments in the Northeast. As such, this is the first record of *S. fuscoides* for Brazil and for the Neotropics (Lado & Basanta 2008).

Reports of members of the *Stemonitaceae* associated with mangroves are rare, despite the fact that species in this group of myxomycetes occupy many of the microhabitats potentially available in different ecosystems throughout the world. For example, Nieves-Rivera & Stephenson (2004) reported the occurrence of *Stemonitis splendens* Rostaf. on *R. mangle* for Puerto Rico. Similarly, in the two papers that provide information on the presence of myxomycetes in Brazilian mangroves, Bezerra et al. (1999) and Cavalcanti et al. (2000) recorded the presence of *Comatricha* sp. on *R. mangle* and *Collaria arcyrionema* (Rostaf.) Nann.-Bremek. on *Laguncularia racemosa* (L.) C.F. Gaertn. (*Combretaceae*). Likewise, in a recent study carried out in a mangrove forest in the state of Santa Catarina, southern Brazil, Trierveiler-Pereira et al. (2008) reported that six species of myxomycetes were collected directly in the field from the bark of the trunk of *Avicennia schaueriana* Stapf & Leechm. ex Moldenke (*Avicenniaceae*); two of these were identified as *Stemonitis fusca* Roth and *S. splendens*. No reports are known of the occurrence of *Stemonaria* in this kind of environment. Therefore, the findings from Pernambuco are the first record for this genus in mangroves at world level.

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Fig. 1. a. *Stemonaria fuscoides* (= 0.5 mm); **b.** *Stemonaria fuscoides,* sporocarps with the characteristics of the var. *longipes* (= 0.5 mm); **c.** Bifurcate columella (= 50 μm); **d.** Presence of nodules in the capillitium (= 50 μm); **e.** Spinulose spores with reticulations (= 10 μm); **f.** Capillitium and columella (= 50 μm).

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Species, host range, and geographical distribution of powdery mildew fungi in Iran

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Abstract — A comprehensive review of the species, host range and geographical distribution of powdery mildew fungi in Iran is presented. The listed fungi belong to eight teleomorphic genera — *Blumeria* (1 species), *Erysiphe* sect. *Erysiphe* (14 species), *Erysiphe* sect. *Microsphaera* (15 species), *Erysiphe* sect. *Uncinula* (6 species), *Golovinomyces* (9 species), *Leveillula* (14 species), *Neoerysiphe* (2 species), *Phyllactinia* (3 species), *Podosphaera* sect. *Podosphaera* (3 species), *Podosphaera* sect. *Sphaerotheca* (12 species), and *Sawadaea* (2 species) — and one anamorphic genus, *Oidium* (five species). The 528 host plant species reported in the checklist pertain to 287 genera. The complete checklist of fungi is available on http://staff.guilan.ac.ir/staff/users/khodaparastm/fckeditor_repo/file/Checklist.pdf.

Key words — biotrophic fungi, biodiversity, *Erysiphaceae*

Introduction

Fungi belonging to the order *Erysiphales* are widely distributed all over the world and cause powdery mildew diseases on numerous wild as well as cultivated plants. The knowledge of powdery mildew species in particular areas is important for understanding the biology and taxonomy of these fungi as well as for phytopathological purposes. During the past ~150 years, many fungi have been collected in and around Iran, including representatives of the *Erysiphales*. However, powdery mildews have never been extensively studied in Iran, so that information on the species and their host plants is scattered in various plant pathological reports and some general fungal lists (Esfandiari 1946a,b, 1947, 1948, 1951; Eskandari 1964; Petrak 1941, 1949, 1953; Petrak & Esfandiari 1941; Sharif & Ershad 1966; Altman et al. 1972; Ershad 1971, 1995). To our knowledge, Rabenhorst (1871), citing two species of powdery mildew from Iran, was the first to report *Erysiphales* from the country. Some recent

publications include lists of the powdery mildew fungi from Iran, but these have been incomplete and restricted to regional studies (Khodaparast et al. 2000b, 2001; Tajik-Ghanbary et al. 2005; Tavanaei et al. 2005; Pirnia et al. 2007). The aim of this paper is to provide a comprehensive review of the species, host range, and geographical distribution of powdery mildew fungi in Iran.

Materials and methods

Between 2002 and 2007 numerous new collections and herbarium specimens of *Erysiphales* from Iran were examined using light microscopy. In addition, a list of the species, including their host plant species and geographical distributions, were compiled using data from the literatures. The generic taxonomy was based on the new genus concepts introduced by Braun (1999), Braun & Takamatsu (2000), and Braun et al. (2002). Species identification followed Braun (1987, 1995) and recent papers (Khodaparast et al. 2000a, 2002; Shin 2000; Braun et al. 2001, 2006; Takamatsu et al. 2007; Braun & Minnis 2008). Host plant nomenclature follows The International Plant Names Index and Flora Europaea (Anonymous 2008a,b).

Results

Table1. Overview of the taxa of the *Erysiphales* and their host plant genera and species reported from Iran

Genus	Number of fungal species	Number of host plant genera	Number of host plant species
Blumeria	1	21	53
Erysiphe sect. *Erysiphe*	14	60	92
Erysiphe sect. *Uncinula*	6	8	15
Erysiphe sect. *Microsphaera*	15	13	23
Golovinomyces	9	43	61
Leveillula	14	116	187
Neoerysiphe	2	8	10
Phyllactinia	7	23	42
Podosphaera sect.*Sphaerotheca*	12	28	44
Podosphaera sect. *Podosphaera*	3	5	10
Sawadaea	2	1	8
Oidium	5	85	96

A total of eight teleomorphic genera and 90 species of the *Erysiphales* were identified in Iran. According to our results these fungi parasitized approximately 528 host plant species in this country. The names of the powdery mildew genera, the number of species per genus, the number of host plant genera and

species are summarized in Table 1. The complete alphabetical checklist, which lists all powdery mildew taxa, host plant species, collection sites, and relevant references, can be downloaded from http://staff.guilan.ac.ir/staff/users/khodaparastm/fckeditor_repo/file/Checklist.pdf. The cited 528 host plant species represent 287 genera. It is expected that more collections and further taxonomic studies will substantially increase our knowledge on the presence of these fungi in Iran.

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Rattania setulifera, an undescribed endophytic hyphomycete on rattans from Western Ghats, India

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Abstract – *Rattania setulifera* gen. et sp. nov., isolated from fresh leaves of rattan (*Calamus thwaitesii*), is described and illustrated. The endophytic hyphomycete is characterized by setose sporodochia, branched conidiophores, monoblastic, sometimes sympodial conidiogenous cells and slimy, fusiform, aseptate to multiseptate, curved conidia bearing tiny setulae at both ends.

Key words – biodiversity, anamorphic fungi, taxonomy, tropical forests

Introduction

During studies on the diversity of microfungi associated with plants of the Western Ghats, an undescribed dematiaceous hyphomycete was isolated from fresh leaves of rattan. This fungus is distinguished by a unique combination of features that warrant its accommodation in a new genus, described here.

Materials and methods

Freshly collected leaf laminae of *Calamus thwaitesii* Becc. (*Arecaceae*) were surface sterilized in 70% ethanol (1 min), 4% sodium hypochloride (3 min) and 70 % ethanol (30 s) and thoroughly rinsed in sterile distilled water. Each leaf lamina was cut into 5 mm square pieces and plated on malt extract agar (MEA, HiMedia) plates (9 cm diam., Borosil glass) with antibiotics incorporated (composition in 1 L: 5 g malt extract, 20 g agar, 20 mg each of bacitracin, neomycin, penicillin, streptomycin and tetracycline). The plates were incubated at 25°C with diurnal light for 15 days. The fungus appeared on the surface of cut leaf pieces as sporodochia. A pure culture of the fungus was obtained by transferring spores from the sporodochium into fresh MEA plates.

Taxonomic description

Rattania Prabhugaonkar & Bhat, **gen. nov.**

MycoBank MB512876.

Ad fungos conidiales, hyphomycetes. Sporodochia atro brunnea, setosus. Setae rectae vel flexuousae, non ramosae, atro brunneae. Conidiophora distinctus, ramosa, laevia, hyalina, formans densus fasciculus. Cellulae conidiogenae integratae vel discretae plerumque monoblasticae, aliquando extensus sympodialiter semel vel bis ad producens successivus solitaria holoblastica conidia, cicatrices conidiales inconspicuae, planus. Conidia mucosus, solitaria, fusiformis, curvatus, hyalina, laevia, 0–multiseptatus, basi anguste truncata, acuminatus ad apicem, utrinque una setula praedita.

Species Typica: *Rattania setulifera* Prabhugaonkar & Bhat

Etym.: *Rattania* — Host of type species is a rattan

Conidial fungus, hyphomycetes. Sporodochia superficial, gregarious, dark brown, setose, with a small stroma at the base. Setae erect, straight to flexuous, unbranched, rhizoidal at base, tapering to a pointed apex, septate, smooth, thick-walled, dark brown. Conidiophores distinct, branched, smooth, hyaline, arising in a palisade layer from a pseudoparechymatous stroma. Conidiogenous cells terminal, integrated or discrete, usually monoblastic, sometimes extending sympodially once or twice to produce successive solitary holoblastic conidia, after secession leaving an inconspicuous, flat secession scar with no evident wall thickening. Conidia slimy, solitary, fusiform, curved, hyaline, smooth, 0–multiseptate, thin-walled, truncate at the base, acuminate at the tip, setulate at both ends.

With sporodochial conidiomata, holoblastic conidiogenous cells and setulate conidia, genera such as *Fumagopsis* Speg., *Hyphodiscosia* Lodha & K.R.C. Reddy, *Mycocentrospora* Deighton and *Megalodochium* Deighton show some affinity with *Rattania* (Ellis 1971, 1976, Carmichael et al. 1980) (Table 1, p. 222). The genus *Fumagopsis,* typified by *F. triglifioides* Speg., has setose sporodochia and holoblastic, discrete conidiogenous cells but differs from *Rattania* by producing catenate, non-setulate conidia (Spegazzini 1910). In *Hyphodiscosia,* typified by *H. jaipurensis* Lodha & K.R.C. Reddy, conidiophores are mononematous and conidia are holoblastic and setulate. In *Mycocentrospora,* typified by *M. acerina* (R. Hartig) Deighton, conidiophores develop in fascicles without setae and conidia bear a 1-septate appendage at the base. In *Megalodochium,* typified by *M. palmicola* Deighton, conidiomata are sporodochial, without setae, conidiogenous cells integrated, terminal or discrete and conidia are aseptate, dark brown, densely spinulose and without setulae (Ellis 1976). None of these have the combination of characters that define *Rattania*, namely setose sporodochia, monoblastic, sometimes sympodial, integrated as well as discrete conidiogenous cells and 0–multiseptate, slimy, hyaline, fusiform conidia with setulae at both ends.

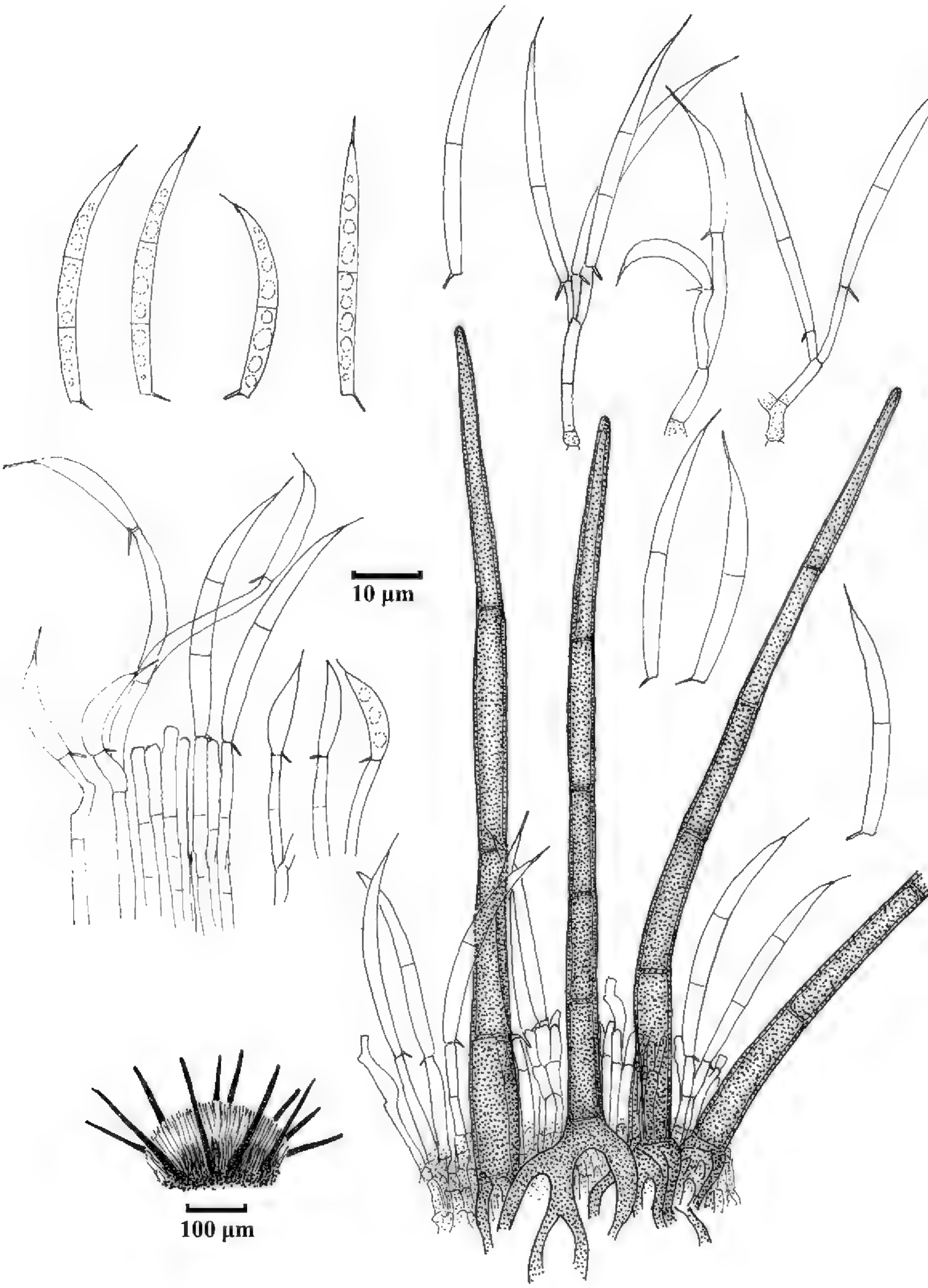

FIG. 1: *Rattania setulifera.* Sporodochium, setae, conidiogenous cells and conidia.

The hyphomycete genus *Minimidochium* B. Sutton has much similarity with *Rattania* in having a stromatic base, setose sporodochia and fusiform, setulate conidia; it differs by having phialidic conidiogenous cells with a distinct collarette and aseptate conidia with rounded ends (Ellis 1976).

Coelomycetes genera such as *Chaetopatella* I. Hino & Katum. (Nag Raj 1974), *Shanoria* Subram. & K. Ramakr. (Morgan-Jones et al. 1972a) and *Heteropatella* Fuckel (Morgan-Jones et al. 1972b) have similar setulate conidia but possess pycnidial fruiting bodies.

Rattania setulifera Prabhugaonkar & Bhat, **sp. nov.** FIGS 1–2

MYCOBANK MB 512877

Coloniae in substrato effuse; in MEA-cultura effusae, planus, margine fimbriatus, granularis, pallide aurantiacus 3 cm diametro in 10 dies. Sporodochia atro brunnea, setosus, 160–490 × 100–450 µm. Setae non ramosae, ad apicem acutus, saepe e rhizoideis conspicuis, 2–6 septis, atrobrunneae, 85–370 µm longa, 4–13 µm lat. ad basim, 3–10 µm lat. in medius, crassitunicatae, usque ad 1 µm lat. Conidiophora ramosa, hyalina, formans densus fasciculus, usque ad 30 µm longa. Cellulae conidiogenae terminales, integratae vel discretae plerumque monoblasticae, aliquando extensus sympodialiter semel vel bis ad producens successivus solitaria holoblastica conidia, uterque extensus circa 4–8 um longa, cicatrices conidiales inconspicuae, planus, non-incrassatae 3–13 × 1.5–2.5 µm. Conidia mucosus, fusiformis, deorsum truncata, acuminatus ad apicem, 0–5 (plerumque 1–2) septis, utrinque una setula praedita, 25–50 µm longa, 1.5–3.5 µm lat. ad basim. Setula basalis, excentrica, 1–3 µm longa. Setula apicalis extensus e conidia acutatus apicem, 2–5 µm longa.

HOLOTYPE: On fresh leaves of *Calamus thwaitesii*, A. Prabhugaonkar, 21/08/2008, Dhoodhsagar, Goa, India. Herb. No. HCIO 48776; ex type culture No. GUFCC 15501.

ETYM.: *setulifera* – having setulate spores

COLONIES on the substratum effuse; on MEA slow growing, effuse, flat, with fringed margin, granular, pale orange, up to 3 cm diam. in 10 days. SPORODOCHIA superficial, gregarious, scattered on leaf pieces placed on MEA, dark brown, setose, with dark brown stromatic base, 160–490 × 100–450 µm. SETAE unbranched, erect, straight to flexuous, rhizoidal at the base, tapering towards apex into an acute tip, smooth, 2–6-septate, unbranched, thick-walled, walls up to 1 µm wide, dark brown, 85–370 µm long, 4–13 µm wide at base, 3–10 µm wide in middle. CONIDIOPHORES arising from the stroma, branched, hyaline, forming dense clusters, up to 30 µm tall. CONIDIOGENOUS CELLS terminal, integrated or discrete, usually monoblastic, sometimes extending sympodially once or twice to produce successive solitary holoblastic conidia, each extension about 4–8 um long, after secession leaving an inconspicuous, flat secession scar with no evident wall thickening, 3–13 × 1.5–2.5 µm. CONIDIA slimy, solitary, fusiform, truncate at the base, acuminate at the tip, hyaline, smooth, thin-walled, 0–5 (mostly 1–2) septate, 25–50 µm long, 1.5–3.5 µm wide at base and middle; setulate at both ends, setula at the base attached to one side, 1–3 µm long, at the apex 2–5 µm long.

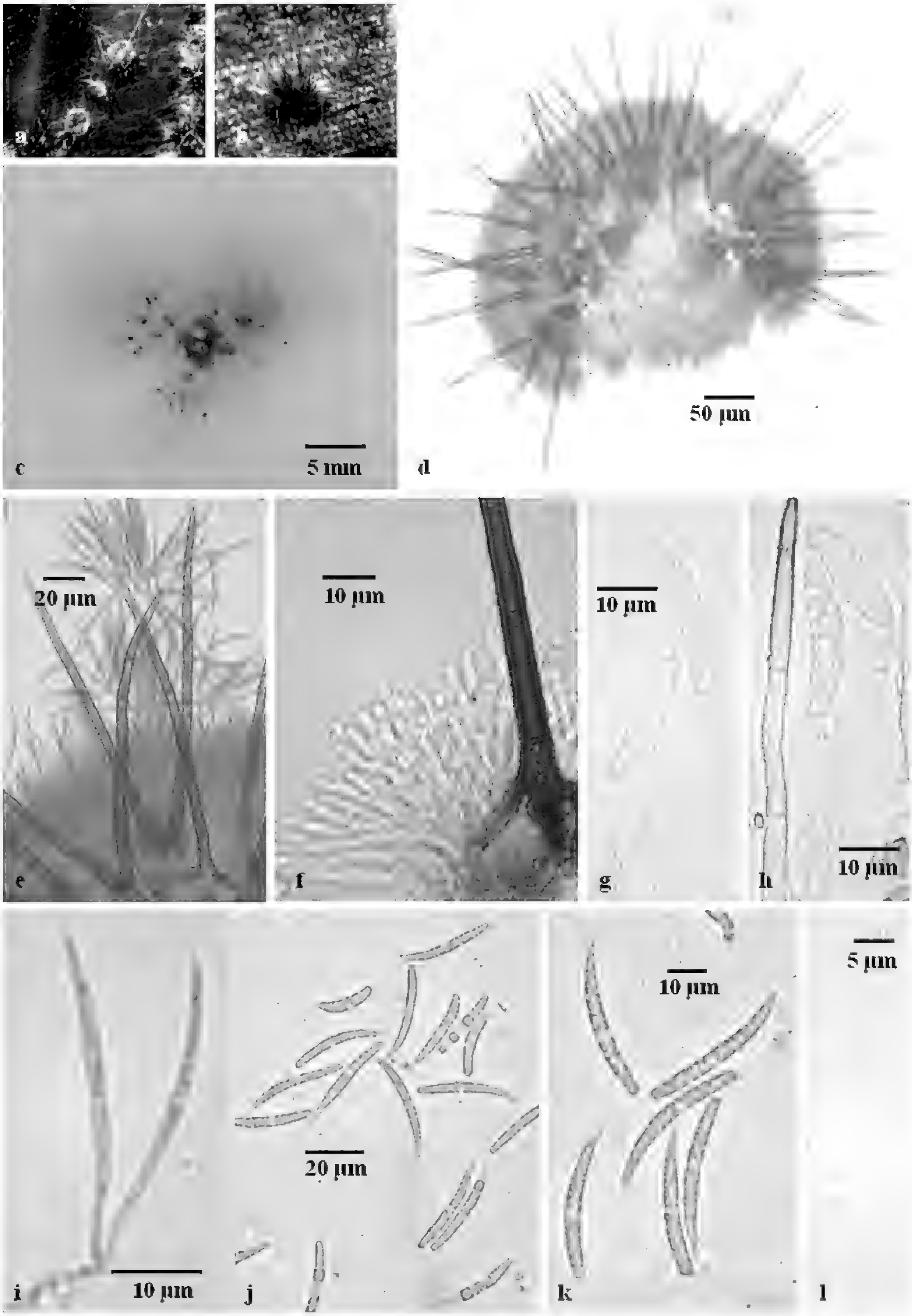

FIG. 2: *Rattania setulifera*. a–b. Sporodochia on host tissue; c. Colony on agar plate; d. Sporodochium; e–f. Setae, conidiogenous cells and conidia; g–i. Sympodial conidiogenous cells with attached conidia; j–l. Conidia with setulae.

TABLE 1: Comparison of *Fumagopsis, Hyphodiscosia, Megalodochium, Mycocentrospora* and *Rattania.*

GENUS	CONIDIOMATA	CONIDIOGENOUS CELLS	CONIDIA & SETULAE
Fumagopsis	Sporodochia, with setae	Discrete, determinate, subcylindrcal, holoblastic	Catenate, triradiate, with truncate base and obtuse apex, without setulae
Hyphodiscosia	Mononematous, without setae	Integrated, polyblastic	Rounded at apex, truncate at base with setulae at each end
Mycocentrospora	Mononematous, fasciculate, without setae	Integrated terminal, polyblastic	Hyaline with broader cells pale brown, obclavate with truncate base and with 1-septate lateral appendage at basal end
Megalodochium	Sporodochia, without setae	Holoblastic, mostly integrated and terminal but sometimes discrete	Ellipsoidal, somewhat flattened, 0-septate, dark brown, densely spinulose, without setulae
Rattania	Sporodochia, with setae	Integrated, terminal or discrete, monoblastic, sometimes sympodial	Hyaline, fusoid, acuminate apex, truncate base, 0–3 septate, with setula at each end

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Taxonomy and chemical aspects of *Psilocybe wrightii* from southern Brazil

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Abstract — *Psilocybe wrightii* (*Strophariaceae, Agaricales*), a subtropical and hallucinogenic species known only from southern Brazil and northern Argentina, is confirmed to contain psilocybin and psilocin. Detailed description of southern Brazilian specimens, chemical analysis using gas chromatography of the basidiomes, and discussion of its taxonomy are presented.

Key words — *Psilocybe* sect. *Cordisporae,* screening, toxic mushroom

Introduction

Species of *Psilocybe* (Fr.) P. Kumm. are the most important hallucinogenic mushrooms in the world (Guzmán 1983, Stamets 1996), comprising about 150 neurotropic species, among 227 taxa worldwide (Guzmán 2005). Most of the so-called hallucinogenic species are included in *Psilocybe* sections *Aztecorum* Guzmán, *Brunneocystidiatae* Guzmán, *Cordisporae* Guzmán, *Cubensis* Guzmán, *Mexicanae* Guzmán, *Semilanceatae* Guzmán, *Stuntzii* Guzmán, and *Zapotecorum* Guzmán, following infrageneric classification of Guzmán (1983, 1995). However, many of these species have not been chemically studied, although they are considered to be neurotropic due to the bluing feature of the basidiomes when injured or touched (Guzmán 1983). The bluing color is the oxidative reaction of the main toxins involved —psilocybin and psilocin (Benedict & Tyler 1967). Molecular systematics research supports separation of psilocybinic taxa of *Psilocybe* (clade '/psychedelia' of Moncalvo et al. 2002) from the non-bluing species (Matheny et al. 2006). Redhead et al. (2007) propose conserving the genus *Psilocybe* with *P. semilanceata* (a hallucinogenic

species) as conserved type; the name *Deconica* (W.G. Sm.) P. Karst. would then be available for the non-hallucinogenic clade.

Guzmán (1978) was the first to study the Brazilian *Psilocybe* mycobiota. Present knowledge is summarized by Guzmán & Cortez (2004), who cite 29 species, including 21 neurotropic taxa. In the same paper, the authors report *P. wrightii*, a species known until then only from the holotype, collected in 1971 in the region of Tucumán, Argentina (Guzmán 1978). This mushroom was found to be common near small rivers and very humid places in southern Brazil, where medium-sized basidiomes exhibited the features typical of the bluing species (Silva et al. 2006). This investigation was proposed to provide further taxonomic and chemical data on this species, especially regarding the presence of hallucinogenic compounds.

Materials and methods

Samples – Specimens were collected in the municipality of Santa Maria, central Rio Grande do Sul State, in southern Brazil. The specimens were photographed in situ, collected, and then analyzed macro- and micromorphologically following previously described methods (Guzmán 1983). Color codes follow Kornerup & Wanscher (1978). A minimum of 25 microstructures (basidia, basidiospores, cystidia and hyphae) were observed, which were drawn with the aid of a light tube at magnification of 1000x. The studied collections are preserved at the herbarium ICN (Instituto de Biociências, Universidade Federal do Rio Grande do Sul).

Chemical analysis – The hallucinogenic compounds (e.g., psilocybin and psilocin) were extracted through decoction using previously dried mushrooms (100 mg) and methanol (10 mL), 70°C for 30 minutes so that the resulting extract could be analysed without preconcentration. Psilocybin and psilocin detection methods include thin layer chromatography employing silica gel GF_{254} and methanol : NH_4OH (10:0.25) as mobile phase and platinized potassium iodine as the chromogenic reagent. These samples were analyzed by gas-chromatography-mass spectrometry (GC/MS) on a chromatograph (Shimadzu GC-17A) equipped with a fused silica capillary column 30 m × 0.25 mm × 0.25 μm, coated with DB-5 and a quadrupole MS system (QP 5000) operating at 70 eV. Injector temperature was set at 250 °C. The oven temperature was programmed from 180°C to 320°C at 20°C/min and helium was employed as carrier gas (1 mL/min). Percentage compositions were obtained from electronic integration measurements without taking into account relative response factors. Prior to GC analyses, the methanolic extracts were submitted to derivatization with BSTFA (N-O-bis-trimethylsilyl-trifluoracetamide) following methods adapted from Keller et al. (1999).

Fig. 1. Fresh basidiomes of *Psilocybe wrightii*.

Results and discussion

Psilocybe wrightii Guzmán, Mycotaxon 7: 251, 1978. Fig. 1–6

Pileus 28–49 mm diam., convex to applanate, umbonate, golden brown (5D8) to yellowish brown (5C7) or light orange (5A4) toward the margin, which can present greenish tones; surface smooth, dry to moist, and strongly hygrophanous; margin smooth to striate when dried or striatulate and translucent when moist, appendiculate; context whitish, becoming blue after a few minutes (not readily staining); odor strongly farinaceous. Lamellae adnexed, greyish yellow (4C6) when young, violet brown (11F8) when mature, with conspicuously whitish margin, close. Stipe 52–74 × 3–6 mm, central, cylindrical to subclavate, light orange (5A5) to reddish brown (8D6), base white, greenish tones seen in older basidiomes or within a few minutes after injured; surface smooth in the apex becoming squamulose toward the bottom, hollow. Veil not forming an annulus on stipe but producing marginal membranous remnants on pileus, first yellowish then bluish to greenish in older specimens. Spore print dark purple (14F5).

Basidiospores 7.5–9 × 5.5–6.5 × 5–6 µm, subrhomboid in face view, ovoid to subellipsoid in side view, yellowish brown in KOH, smooth and thickened walls (<1 µm thickness), with a small but truncate germ pore. Basidia 17–23.5 × 6–8.5 µm, ventricose to subclavate, with central constriction, tetrasporic, hyaline. Pleurocystidia 12.5–20.5 × 6–9 µm, fusoid to ventricose, apex mucronate or subcapitate, hyaline, but with the apex slightly pigmented and sometimes chrysocystidioid due to the presence of small and yellow contents, walls thin. Cheilocystidia (13.5–)19–23.5(–28) × 3.5–7.5 µm, lageniform to ventricose, apex sometimes forked, hyaline, with pigmented apex, very numerous making the gill edge completely sterile. Caulocystidia 20–29.5 × 5–7 µm, mainly clavate, sometimes forked, apex obtuse, occasionally mucronate, hyaline, in small clusters on stipe apex. Pileipellis an ixocutis formed by filamentous, little gelatinized, 2–4 µm diam. hyphae, hyaline and with smooth and thin walls. Context subcellular, formed by subglobose, 8.5–31 µm diam. elements, with yellow and slightly thickened walls. Lamella trama subregular, composed by hyaline to pale yellow hyphae, 5–15 µm diam., with smooth and thin walls. Stipitipellis composed by hyaline hyphae, 6–11 µm diam., smooth and thin-walled. Clamp connections present in most septa.

Specimen examined: **BRAZIL.** Rio Grande do Sul: Santa Maria, Três Barras, 14 Mar 2008, *V.G. Cortez 064/08* (ICN).

Taxonomic discussion – *Psilocybe wrightii* was described from Argentina (Guzmán 1978) and later reported from southern Brazil (Guzmán & Cortez 2004), where it has been recently encountered in several localities (Silva et al. 2006, 2008). The basidiomes grow solitary or gregarious in riparian forests or

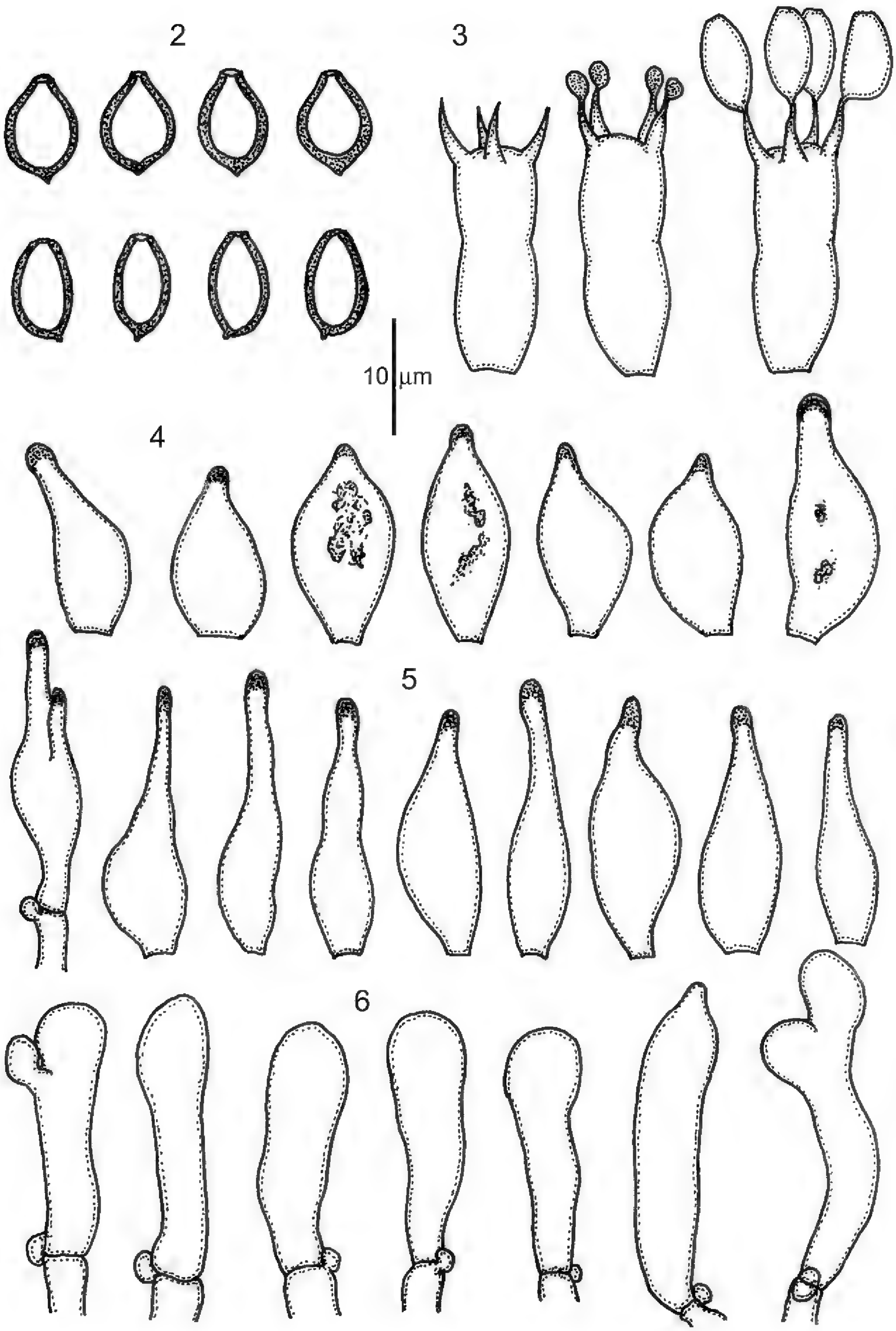

FIG. 2–6. *Psilocybe wrightii.*
2. Basidiospores. 3. Basidia. 4. Pleurocystidia. 5. Cheilocystidia. 6. Caulocystidia.

near small rivers in the autumn (April to June). Based on basidiospore size and shape, presence of pleurocystidia, and the bluing feature of the basidiomes, Guzmán (1983) placed the species in *Psilocybe* Sect. *Cordisporae*, which is widely represented in the Neotropical area.

Psilocybe heliconiae Guzmán et al., described from Colombia, shares similar size and shape of the basidiospores, pleurocystidia and cheilocystidia as well as similarities in the basidiome appearance (Guzmán et al. 1994). This similarity was emphasized in Guzmán et al. (1994) and Guzmán & Cortez (2004), but only with evaluation of additional collections to establish the variation from young to mature basidiomes can the taxonomic relationships between these species be clarified.

Chemical analysis – After extraction, on sorting analysis, all the samples showed an intense characteristic reaction with the chromogenic agent in thin layer chromatography, presenting Rf values of 0.39 for psilocin and 0.5 for psilocybin. Psilocybin and psilocin were also detected through gas chromatography. Derivatization increased the sensitivity of the detector (Lanças 1993). This reaction was performed with BSTFA, producing bis-trimethyl-silyl-psilocybin and bis-trimethyl-silyl-psilocin, which showed a retention time of 10.683 min and 10.592 min, respectively. The identity of these derivatives was confirmed by the presence of the characteristic fragments *m/z* 58, 189 and 261 for bis-trimethyl-silyl-psilocybin and 58, 290 and 348 for bis-trimethyl-silyl-psilocin. Differences in the psilocin and psilocybin contents in hallucinogenic mushrooms depends on factors such as developmental stage, weather conditions, and the availability of soluble nitrogen and phosphorous in the soil (Tsujikawa et al. 2003).

These results confirm the presence of psilocin and psilocybin for the species and, consequently, the hallucinogenic potential of *Psilocybe wrightii*.

Acknowledgments

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A new species of *Pertusaria* (*Pertusariaceae*) from China

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Abstract — *Pertusaria parapycnothelia* is described as new to science. The species is characterized by asci with 3 ascospores and the presence of 2'-*O*-methylperlatolic acid.

Keywords — lichen, taxonomy, Yunnan

Introduction

Yunnan province is located in the southwest of China, east of the great Himalaya, between 21° 8′ 22″–29° 15′ 8″ N and 97° 31′ 39″–106° 11′ 49″ E. The terrain has an average altitude of ca. 2000m with the highest peak of Meili Mountain over 6700m in the northwest and lowest at Hekou about 76m in the south. This area is well known for a very diverse biota, and a very rich lichen flora is similarly expected, but many genera and places still remain incompletely investigated (Harada et al. 2004).

Since the publication of Zhao et al. in 2004 (Zhao et al. 2004), two new species of the lichen genus *Pertusaria* have been reported from China (Ren et al. 2008). Further study of the genus from Yunnan has revealed an additional species, which is here described as new to science.

Material and methods

The type specimen was collected in Yunnan province, southwestern China, and is preserved in SDNU (the Lichen Section of Botanical Herbarium, Shandong Normal University).

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A dissecting microscope (Motic K-400L) and a research microscope (JNOEC XS-213) were used for the morphological and anatomical studies. Lichen substances were detected by thin-layer chromatography (TLC) (Elix & Ernst-Russell 1993).

Taxonomic description

Pertusaria parapycnothelia Q. Ren & Z.T. Zhao, **sp. nov.** FIGURES 1–4
MYCOBANK MB 512990

Similis Pertusaria pycnothelia *sed ascis trisporis et 4,5-dichlorolichexanthone deficiens differt.*

Typus: CHINA. *Yunnan provincia, Lijiang, Xiangshan, alt. 2400m, ad corticem arborum, J.C. Wei 2738. (holotypus in HMAS-L).*

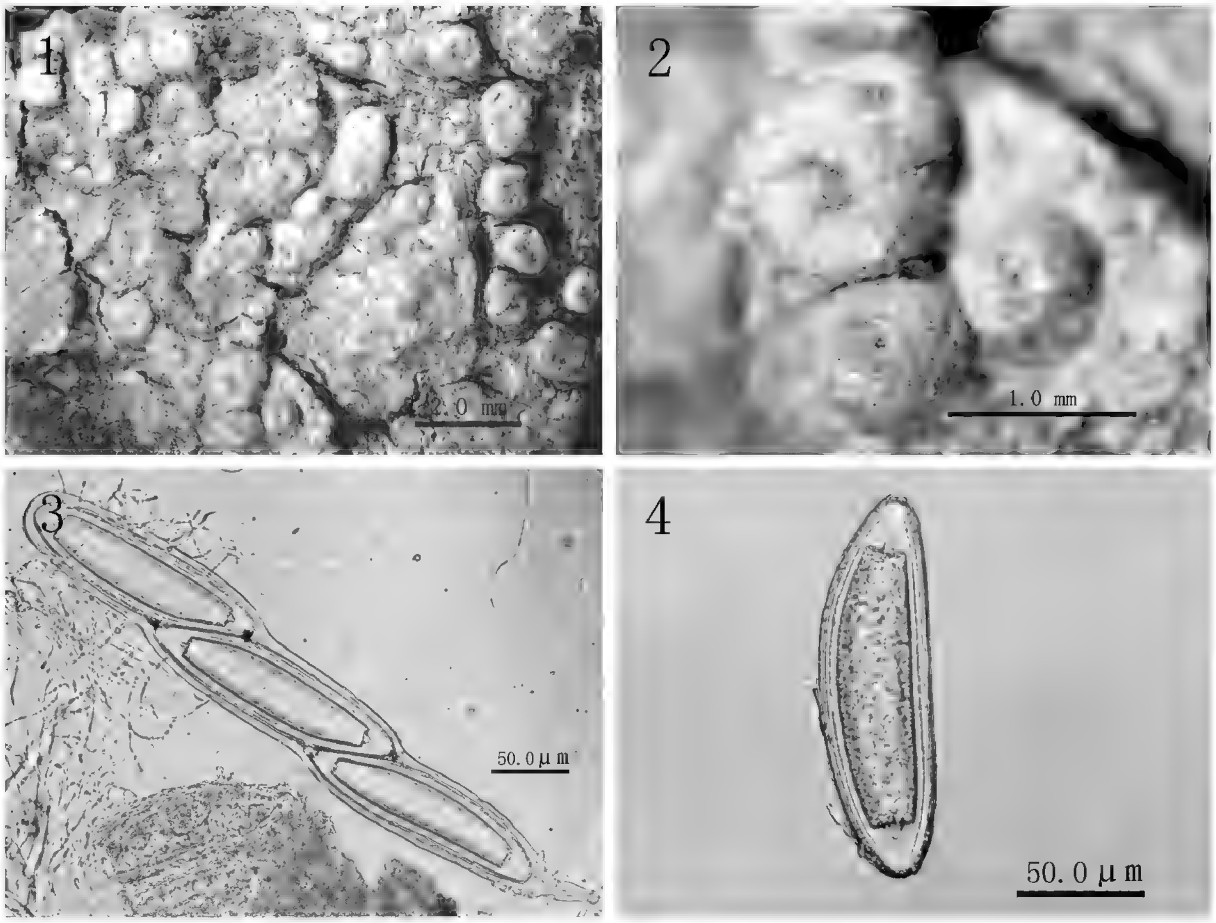
ETYMOLOGY: from the Greek *para*, near, a reference to the similarity of the new species to *Pertusaria pycnothelia*.

Thallus crustose, thin, pale fawn, surface smooth; lacking soredia and isidia; corticolous; apothecia verruciform, scattered, sometimes confluent, concolorous with the thallus, hemispherical to flattened hemispherical, 0.5–1.2 mm diam. sessile, constricted at the base; ostioles conspicuous, black, punctiform, in a translucent, pale brown zone, 0.3–0.5 mm diam., 1–5 per verruca; ascospores (2–)3 per ascus, ellipsoid to subfusiform, (129–)140–168 µm long, 35–40(–54) µm wide, double-walled, smooth, 7–11 µm thick, inner wall distinctly trimmed, the end wall 17–23 µm thick; pycnidia not seen.

CHEMISTRY: K–, C–, KC–, Pd–, UV–; 2′-*O*-methylperlatolic acid (TLC).

DISTRIBUTION AND SUBSTRATE —At present, *Pertusaria parapycnothelia* is known only from the type locality where it occurs on *Quercus*.

COMMENTS — *Pertusaria parapycnothelia* is characterised by asci with 3 smooth ascospores and the presence of 2′-*O*-methylperlatolic acid. The new species resembles *P. pycnothelia* Nyl. but differs from that species by the number of ascospores per ascus and ostioles per verruca. *P. pycnothelia* has 2-spored asci and verrucae with only 1 ostiole (Archer 1997), whereas the new species has asci with 3 (rarely 2) ascospores and verrucae with 1–5 ostioles. The new species is chemically identical to *P. buburana* Elix & A.W. Archer and *P. uttaraditensis* Jariangpr., but both of these species are sterile (Elix et al. 1997, Jariangprasert et al. 2005). The new species somewhat resembles the chemically identical saxicolous species *P. spegazzinii* Müll. Arg. (Müller 1889) from the southern hemisphere (Tierra del Fuego and the Falkland Islands), but that species has four [and larger (145–185 × 50–65 µm)] ascospores per ascus and larger, more conspicuous black ostioles.



FIGURES 1–4. *Pertusaria parapycnothelia* (J.C. Wei 2738). 1. Morphology (bar = 2 mm); 2. Apothecia (bar = 1 mm). 3. Ascus (bar = 50 μm); 2. Ascospore (bar = 50 μm).

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Dacampia rubra sp. nov. (*Ascomycota, Dacampiaceae*), a lichenicolous fungus on vagrant *Aspicilia* species

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Abstract—*Dacampia rubra* sp. nov. is described on vagrant *Aspicilia* species from eastern Turkey and the Russian Federation. It is most similar to *D. rhizocarpicola*, an imperfectly known species described from *Rhizocarpon obscuratum*, but it differs from that species in the ascomata arising singly and is unique in the genus in having an orange-red pigmented region of the exciple surrounding the ostiole. The new species is the first *Dacampia* species reported on *Aspicilia*. It is associated with *Phoma*-like conidiomata, as also happens in *D. muraliicola,* but it was unclear whether this was an anamorph or an independent fungus.

Key words—biodiversity, lichens, Anatolia

Introduction

Halıcı & Hawksworth (2008) recognized seven species of *Dacampia* (*Ascomycota, Dothideales, Dacampiaceae*) and provided a key and synopsis to these species, along with drawings of the ascospores. After this study, one species, *D. cladoniicola* was described by Halıcı et al. (2008). Although, the type species of the genus, *D. hookeri*, is an independent lichen (Henssen 1995), the other eight species are lichenicolous and are generally restricted in their host range (Halıcı & Hawksworth 2008). This paper is a further contribution to our knowledge of lichenicolous fungi on vagrant *Aspicilia* species, on which several new species have been recently described (Calatayud & Barreno 2003, Calatayud et al. 2004).

Material and methods

The type material of the new species is deposited in ANES. Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics and a drawing tube. Photomicrographs were prepared on a Nikon Eclipse 80i. Sections were prepared by hand and examined in I (Merck Lugol's iodine and Metzler's iodine, with [K/I] and without [I] pre-treatment with 10% KOH), 10% KOH alone, and water. Ascospore measurements were made in water; the extreme values outside the main range are given in parentheses. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Dacampia rubra Halici, Candan & Calat., **sp. nov.** FIGURES 1–2

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Dacampia *species insignis ascosporis (2–)4–6 transseptatiis et (2–)3–5(–6) longiseptatis, (22–)26.5–38.5(–40) × (9.5–)11.5–15(–17) µm (n = 40), l/b = (1.9–)2.2–3.0(–3.3).*

TYPE COLLECTION: Turkey, Malatya, Darende, East of Darende, 38°34'N, 37°31'E, alt. 1200 m, on thallus of a vagrant *Aspicilia* sp. on soil, 09 August 2007, leg. M. Candan (ANES 11138 – **holotype**).

ETYMOLOGY: The epithet "*rubra*" refers to the distinctive colour of the tissues around the ostiole which is unique in the genus.

DESCRIPTION: Lichenicolous, on the thalli of a vagrant *Aspicilia* sp., causing bleaching, pathogenic. ASCOMATA perithecioid, arising singly, immersed with only the ostiole and surrounding zone externally visible, 220–300 µm diam, 3–5 per areole (on vagrant *Aspicilia* sp. collected from Turkey), black, subglobose to obpyriform. Ostiole papilliform, 20–40 µm diam. Exciple composed of 5–7 layers of angular pseudoparenchymatous cells, textura angularis, 20–25 µm thick, but thinner in the upper part, the individual cells in the lower and lateral parts somewhat radially compressed, greenish brown to brown, individual cells 8–10 × 5–6 µm in vertical section, smooth, walls *ca* 1 µm thick; tissue in the upper part of the ascomata 35–40 µm thick, hyphal and radially orientated towards the ostiole, not densely compressed, thick-walled, the cell walls 1.5–2 µm thick, reddish brown in water mounts, with an amorphous, not granular, orange-red pigment reacting K+ purple. HAMATHECIUM of cellular pseudoparaphyses, abundant, septate, branched and anastomosed, 2–2.5 µm wide; periphyses present in the ostiole, septate, not branched, ca. 2 µm in diameter; centrum Lugol's and Metzler's solution (after pre-treatment with 10% KOH) I–. ASCI elongate-clavate to subcylindrical, very shortly stalked, bitunicate in structure, with an apical peak when young, (2–)4-spored in mature asci, 66–117 × (11.5–) 14–17 µm (*n* = 24). ASCOSPORES uniseriately arranged in the mature asci, ellipsoid, dark brown, rounded to somewhat broadly pointed at the apices,

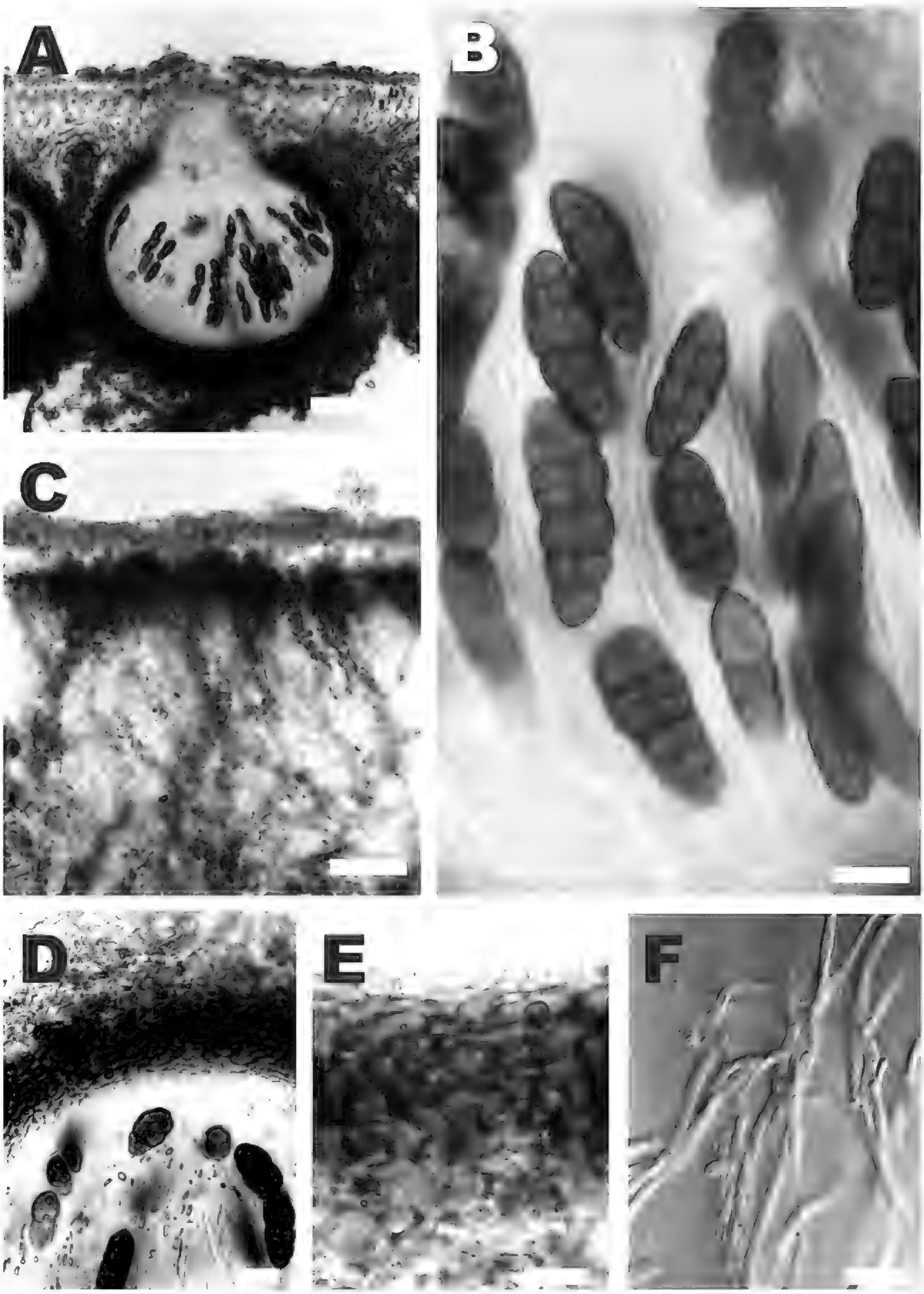

Fig. 1. ***Dacampia rubra*** (UPS 89/140, specimen 29).
A. Ascoma; B. Asci with ascospores; C. Vegetative hyphae (brownish);
D, E. Ascomatal wall; F. Interascal filaments.
Scales: A = 50 µm, B–F = 10 µm.

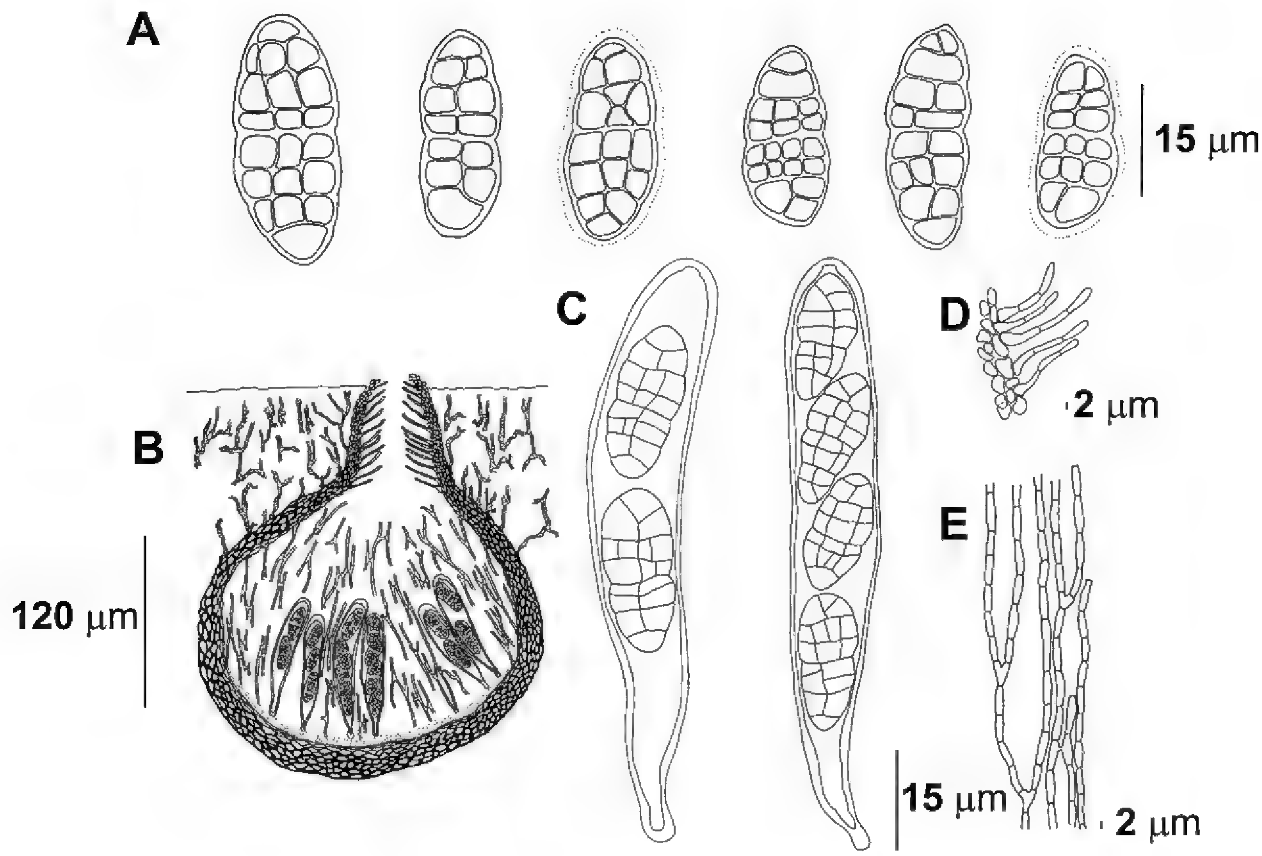

FIG. 2. ***Dacampia rubra*** (UPS 89/140, specimen 29).
A. Ascospores; B. Ascoma; C. Asci; D. Periphyses; E. Interascal filaments.

muriform, with (2–)4–6 transsepta and (2–)3–5(–6) longisepta, verruculose at 1500 × in higher magnifications, slightly constricted at the septa (especially in the medium septa), cells similarly coloured, with a gelatinous sheath, (22–) 26.5–38.5(–40) × (9.5–)11.5–15(–17) µm (n = 40), l/b = (1.9–)2.2–3.0(–3.3), all measurements and ratio including the closely adhering sheath.

Vegetative hyphae sometimes present, arising upwards from the upper half of the ascomatal wall (towards the lichen thallus surface), more or less branched, septate, 2.5–3.5 µm in diam., brownish.

ECOLOGY AND DISTRIBUTION: The species appears to be pathogenic as bleaching is seen in the infected areoles of the host. The type material comes from one locality in eastern Turkey, from where several collections on an unidentified vagrant *Aspicilia* were studied. An additional specimen from the Russian Federation was examined by one of the authors (V.C.) on *Aspicilia fruticulosa*, from material distributed in a Savicz exiccatum. As the host lichens are restricted to continental areas with an Irano-turanian distribution, it should be searched in such localities.

ADDITIONAL MATERIAL EXAMINED: Russian Federation: URSS, Rossia europaea austro-orientalis, regio Astrachanensis, in viciniis lacus Baskunczak in decliviis montis Bogdo

[on *Aspicilia fruticulosa* f. *ferruginea*], anno 1926, V.P. Savicz [Exsicatum V.P. Savicz. Lichenotheca Rossica. Degas X (1960), UPS 89/140, specimen 29].

Observations: *Dacampia rubra* is unique among *Dacampia* species by having an amorphous, orange-red pigment deposited around the ostiole which reacts K+ purple. In addition to the net of interascal filaments, abundant periphyses can be observed lining the ostiolar channel. At present, the genus *Dacampia* includes species with and without periphyses (LIAS 1995–2009), which may be indicative of a certain heterogeneity. The relevancy of this character, however, should be evaluated in the framework of a wider study including *Dacampia* species and taxa of related genera, that should also consider molecular phylogenetic methods (Halıcı & Hawksworth 2008).

Dacampia rhizocarpicola, which was described from a scant material from UK growing in areoles of *Rhizocarpon obscuratum,* is the only other species in the genus with 2–4–spored asci (Halıcı & Hawksworth 2008). This species was described by Halıcı & Hawksworth (2008) with the intent of encouraging the search for more material which could enable a more detailed description to be prepared. *D. rubra* differs from *D. rhizocarpicola* in the ascomata arising singly and the orange red pigmented tissue around the ostiole, as well as the different hosts on different substrates. Also *D. rubra* has dark brown ascospores while *D. rhizocarpicola* has deep golden brown ascospores. *Dacampia hookeri*, has ascospores similar in size to *D. rubra*, but has constantly 8–spored asci, and it is a lichenized species (Henssen 1995).

Phoma-like pycnidial conidomata are intimately associated with the ascomata of *Dacampia rubra*. These are immersed, black, ostiolate, 50–100 (–120) µm diam, the pycnidial wall dark brown, pseudoparenchymatous, 7.5–9.5 µm thick, and composed of 3–5 layers of polyhedral cells. The conidiogenous cells line the inner wall of the pycnidial cavity, are subglobose, not proliferating, hyaline, smooth-walled, 5–7 × 4.5–6 µm, and the conidiogenesis enteroblastic. The conidia are abundantly produced, arising singly, ellipsoid, apically rounded, hyaline, simple, smooth-walled, without guttules, and 6.5–7.5(–9) × 4–4.5(–5.5) µm (n = 20), l/b = 1.6–1.9. Interestingly, not dissimilar pycnidia are also associated with the ascomata of *D. muraliicola* (M.G. Halıcı & D.L. Hawksworth, pers. comm.), but in that case these are 100–150 µm in diam., peridium is composed of 2–3 layers of cells, with conidiogenous cells, 4.5–6 × 3.5–4.5 µm, and smaller conidia, 4–5 × 2.5–3 µm (l/b ratio 1.6). At first we speculated whether these might be anamorphs of these two *Dacampia* species, but while there appeared to be hyphal connections we could not be confident whether these were parasitic or part of the same fungus. Single-spored ascospore cultures or molecular data are required to determine whether these *Phoma*-like pycnidia are part of the same fungi or not.

Acknowledgements

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A re-evaluation of the lignocellulolytic *Agaricomycetes* from the Brazilian semi-arid region

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Abstract — A checklist of the lignocellulolytic *Agaricomycetes* from the Brazilian semi-arid region is provided. It presents data on the distribution of 37 species, 10 families and six orders (*Agaricales*, *Auriculariales*, *Gloeophyllales*, *Hymenochaetales*, *Polyporales*, and *Russulales*). Twenty-eight taxa previously recorded from the studied region are excluded. The full checklist is available at www.mycotaxon.com/resources/weblists.html.

Key words: Caatinga, *Basidiomycetes*, *Aphyllophorales*

Introduction

Agaricomycetes (sensu Hibbett et al. 2007) or *Basidiomycetes* (sensu Kirk et al. 2001) comprises almost 21,000 species of *Basidiomycota* (Kirk et al. 2008) and includes wood-decomposing, parasitic, and ectomycorrhizal fungi (Hibbett 2006). The wood-decomposing fungi are termed lignocellulolytic because their enzymes are able to degrade wood hemi-cellulose, cellulose, and/or lignin, thus causing white and brown rots in plant species (Holf et al. 2004). Northeastern Brazil's semi-arid region (3–7° S and 35–45°W, 955.000 Km^2) encompasses parts of nine States (Fig. 1).The Köppen classification of the climate is 'Bsh' (hot and dry), with an annual mean temperature 25.5°C and characterized by a short rainy (3–5 mos) and long dry (7–9 mos) season; the annual mean precipitation is 600 to 1045 mm (Moura & Ramos 2004). The area is dominated by Caatinga (seasonally dry tropical forest sensu Pennington et al. 2000), composed of typically tropophilous and thorny medium to low xerophytes, where succulent species of the plant families *Cactaceae*, *Euphorbiaceae*, and *Bromeliaceae* stand out in the landscape (Andrade-Lima 1981). Father Camille Torrend was the first researcher to collect and study lignocellulolytic *Agaricomycetes* in this Brazilian biome (Torrend 1940). The 18 *Agaricomycetes*

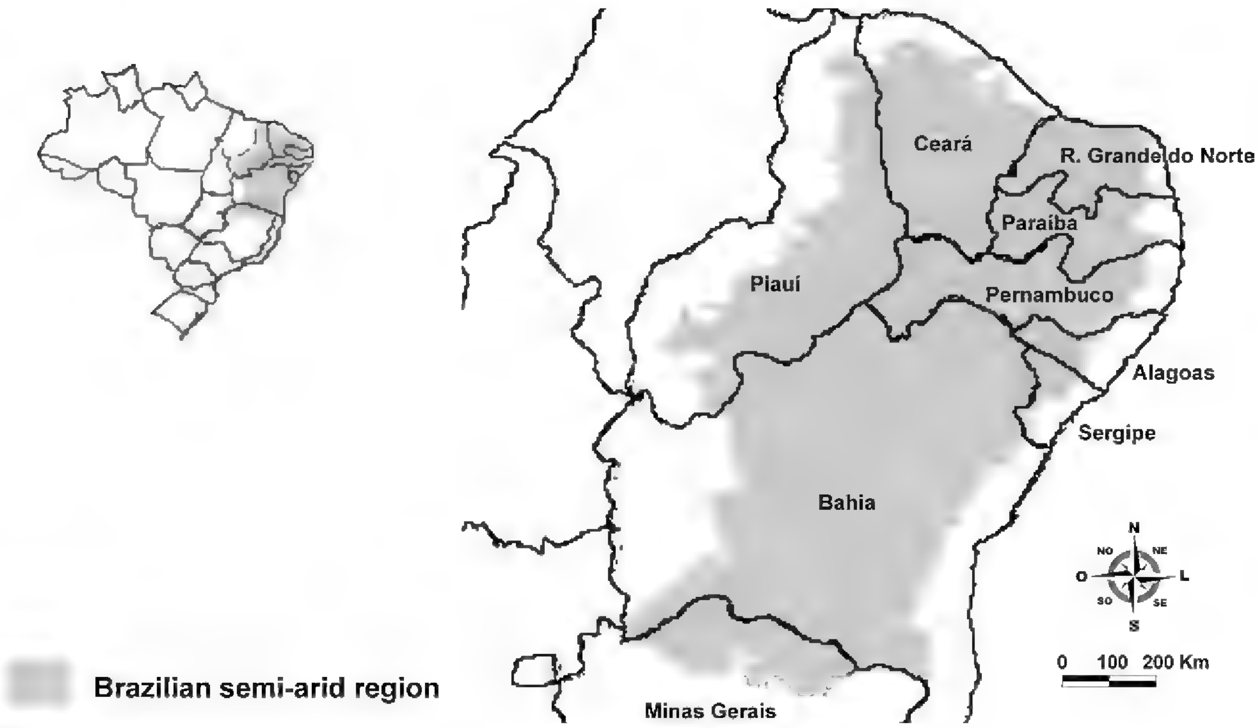

FIGURE 1. Brazilian semi-arid region (modified from: SPR/MI, www.mi.gov.br)

species taxonomically and nomenclaturally revised by Drechsler-Santos et al. (2008a) are deposited in URM, as cited by Maia & Gibertoni (2002). Other works that cover *Agaricomycetes* from this semi-arid region include Góes-Neto et al. (2003), Góes-Neto & Baseia (2006), and Drechsler-Santos et al. (2007). Considering the paucity of information on lignocellulolytic *Agaricomycetes* of Brazil's semi-arid region, this study represents a first comprehensive analysis of the diversity of lignocellulolytic *Agaricomycetes* in this unique biome.

Material and methods

This study was based on bibliographic research (Torrend 1940, Maia 1960, Góes-Neto 1999, Maia & Gibertoni 2002, Góes-Neto et al. 2003, Góes-Neto & Baseia 2006, Drechsler-Santos et al. 2007, 2008a) and revision of fungi exsiccata now curated in ALCB, CEPEC, HUEFS, and URM (Holmgren et al. 1990). The distribution of the species is provided according to occurrence in the States. Nomenclature and classification systems follow those of Hibbett et al. (2007), Index Fungorum (www.indexfungorum.org), and Centraalbureau voor Schimmelcultures (www.cbs.knaw.nl).

Results and discussion

The 37 lignocellulolytic *Agaricomycetes* species reported from Northeastern Brazil's Caatinga region represent 10 families and six orders. *Polyporales* is represented by 23 (62.2%) species, followed by eight (21.6%) species in the *Hymenochaetales*. The higher diversity of *Polyporales* agrees with results of other basidiomycete inventories in both Southern Brazilian subtropical (Drechsler-Santos et al. 2008b) and tropical Northeastern Brazilian Atlantic

forests (Gibertoni et al. 2004). *Polyporaceae* Fr. ex Corda is represented by the highest number of species (17, or 45.9% of the total), followed by 8 species in *Hymenochaetaceae* Imazeki & Toki. The genus with the highest number of species represented is *Phellinus* Quél. s.l. (six, 16.2%). Bahia is the State with highest number of species (33, 89.2%), of which 29 (78.4%) were recorded exclusively in the Bahian semi-arid. Pernambuco is represented by five (13.5%) species, of which *Ganoderma stipitatum* (Murrill) Murrill, *Gloeophyllum striatum* (Sw.) Murrill, and *Phylloporia chrysites* (Berk.) Ryvarden are reported only in this State. *Fomes fasciatus* (Sw.) Cooke was recorded only in Piauí. Only one species each is recorded for the Ceará and Paraíba semi-arid regions: *Favolus tenuiculus* P. Beauv. and *Pycnoporus sanguineus* (L.) Murrill, respectively. No representatives of lignocellulolytic *Agaricomycetes* have been reported from the semi-arid regions of Minas Gerais, Sergipe, Alagoas, or Rio Grande do Norte. Among the species identified thus far, only *Gloeophyllum striatum* causes brown rot; as observed in other tropical and subtropical areas (Nakasone 1996), all other (97.3%) species cause white-rot. We have excluded 28 taxa reported earlier because their exsiccata were not found or are in very poor condition (Drechsler-Santos et al. 2008a). The 37 species of this checklist represent our current knowledge of the diversity and distribution of lignocellulolytic *Agaricomycetes* in Northeastern Brazil's semi-arid region. Further investigations, however, will certainly increase the number fungal records and expand the reported species ranges throughout the area.

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Microbotryum scorzonerae (*Microbotryaceae*), new to China, on a new host plant

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Abstract — A new Chinese record, *Microbotryum scorzonerae* on *Scorzonera albicaulis,* is provided. It was collected from Saihanwula National Nature Reserve, Inner Mongolia Autonomous Region, in northern China.

Key words — *Microbotryales*, *Microbotryum piperi*, smut fungi, taxonomy

A specimen of *Microbotryum* on *Scorzonera albicaulis* was collected from Saihanwula National Nature Reserve, Inner Mongolia Autonomous Region, in the north of China in 2008. This species, which is parasitic on floral heads of host plants belonging to the *Asteraceae* family, has been identified as *Microbotryum scorzonerae*, a species new to China. *Microbotryum scorzonerae* has never previously been reported with *S. albicaulis* as host.

Microbotryum scorzonerae (Alb. & Schwein.) G. Deml & Prillinger, in Prillinger, et al., Bot. Acta 104(1): 10, 1991. Figs. 1–4

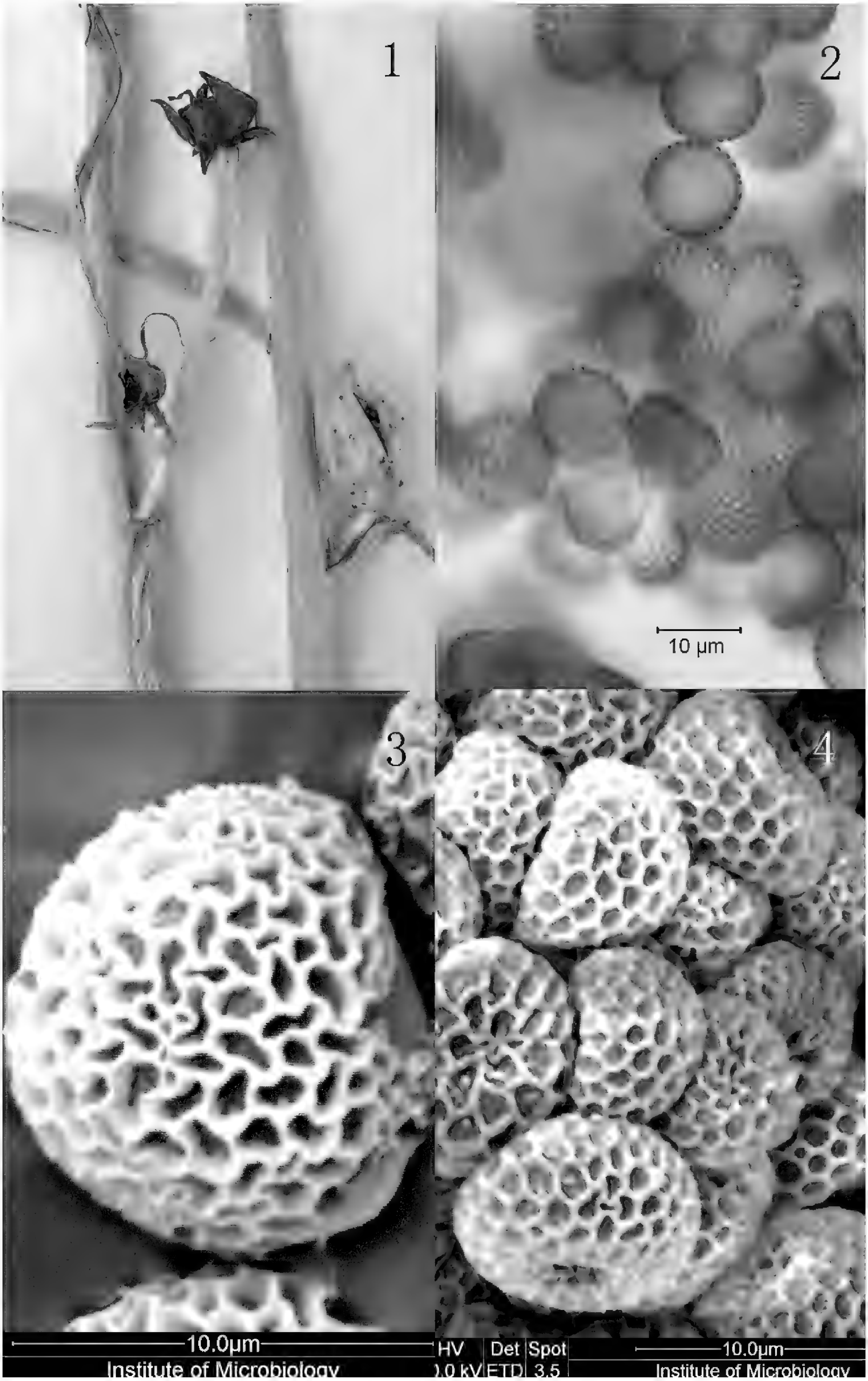
≡*Uredo tragopogonis* ββ *scorzonerae* Alb. & Schwein., Consp. Fung. Lusat. p. 130, 1805.

≡*Ustilago scorzonerae* (Alb. & Schwein.) J. Schröt., in Cohn, Krypt.-Fl. Schlesien 3(1): 274, 1887.

≡*Bauhinus scorzonerae* (Alb. & Schwein.) R.T. Moore, Mycotaxon 45: 99, 1992.

Sori in the floral heads. Spore mass powdery, blackish-violet. Ustilospores when young agglutinated in loose, irregular groups, later single, globose, subglobose,

*corresponding author


1
2
10 µm
3
4
10.0µm
Institute of Microbiology
HV Det Spot
ETD 3.5
10.0µm
Institute of Microbiology

ovoid, ellipsoidal or slightly irregular, 10–16 × 8.5–12.5 μm, light brownish-violet, sometimes paler at one side; wall finely reticulate, meshes 1–3 μm in diameter, muri 1–1.5 μm high, a few warts appear on the lower part of the muri as seen by SEM.

Specimen examined —On *Scorzonera albicaulis* Bunge (*Asteraceae*): China, Inner Mongolia, Chifeng, Saihanwula, 2.IX.2008, T.Z. Liu, H.M. Tian & C. Sun 1406, HMAS 196087.

Previously, four species of smut fungi — *Entyloma guaraniticum* Speg. on *Bidens pilosa* L., *Entyloma dahliae* Syd. & P. Syd. on *Dahlia pinnata* Cav., *Entyloma compositarum* Farl. on *Senecio formosanus* Kitam. and *Thecaphora trailii Cooke* on *Saussurea japonica* (Thunb.) DC. — have been reported as occurring on host plants in the family *Asteraceae* in China (Guo 1991, 2000, 2009). Many more smut species remain to be discovered in the future in China. To date, eleven species of smut fungi have been recorded in Saihanwula National Nature Reserve (Zhang & Guo 2003), including another *Microbotryum* species, *M. piperi* (G.P. Clinton) Vánky on *Polygonum divaricatum* L.

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Figs. 1–4. *Microbotryum scorzonerae* on *Scorzonera albicaulis* (HMAS 196087). 1. Sori. 2. Ustilospores agglutinated in loose, irregular groups as seen by LM. 3–4. Ustilospores as seen by SEM.

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Three new species of *Parmeliaceae* (*Ascomycota*) from Siberia

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Abstract—*Cetrelia sayanensis*, *Myelochroa sibirica* and *M. sayanensis* from Russia (West Sayan Mountains, southern Siberia) are described as new to science. All three species are characterized by the presence of capitate-pustulate or subpustulate soralia, as well as other morphological features and their respective secondary chemistries.

Keywords—*Cetrelia cetrarioides*, *Cetrelia chicitae*, *Cetrelia olivetorum*, *Cetrelia monachorum*, *Myelochroa metarevoluta*, *Myelochroa upretii*

Introduction

In addition to intensive investigations of the lichen flora of southern Siberia (Makry 1990, Urbanavichene & Urbanavichus 1998, Sedel'nikova 2001) we have recently found three new species of *Parmeliaceae* in collections from the West Sayan Mountains. The most interesting region in West Sayan is a relict fir-aspen tall-herbaceous forest situated at 350–500 m altitude and dominated by *Abies sibirica*, *Pinus sibirica* and *Populus tremula* with *Sorbus sibirica*, *Padus avium* and *Salix rorida*. The main substrate for the new species was the bark from *Salix*, *Sorbus,* and *Padus* species, and less frequently the bark from *Abies* and *Betula*. In the dark-fir undershrub-moss taiga situated at higher altitudes

(up to 930 m), the main substrate was *Sorbus sibirica* and, very rarely, *Abies sibirica*.

The new *Myelochroa* taxa differ in a number of characters from recently described sorediate species from China (Wang et al. 2001) and India (Divakar et al. 2001a, b) and also from *M. metarevoluta* (Asahina) Elix & Hale, which is common in Siberia and the Russian Far East.

Material and methods

The lichen specimens were examined using Zeiss Axiostar and Zeiss Stemi 2000C stereomicroscopes and a Zeiss Axiolab compound microscope fittedwith an Axio Imager D1 camera. Chemical constituents were identified by thin layer chromatography (Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and by comparison with authentic samples.

The new species

Cetrelia sayanensis Otnyukova, Stepanov & Elix, sp. nov. Figs 1-8
MycoBank MB 512978

Diagnosis: *Sicut* Cetrelia monachorum *sed soraliis capitato-pustulatibus differt.*

typus—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Kulumys Ridge, 52°58'N, 92°57'E, Kulumys Stream, 800 m alt., on old bark of stem of *Sorbus sibirica*, 24 Jul. 2007, T.N. Otnyukova (**holotype**–KRF; isotypes–KRSU, LE).

etymology: the specific epithet derives from the Latin *-ensis* (place of origin) and the type locality, the Sayan Mountains in southern Siberia.

Thallus foliose, regular to irregular, loosely adnate, 3–6 cm wide. Lobes imbricate, apically rotund or incised, 0.3–1.1(1.5) cm wide. Upper surface gray to greenish-gray, somewhat shiny, with pseudocyphellae, pustules and soredia. Pseudocyphellae laminal, flat, fleck-like, rounded or irregular, whitish, less than 0.1 mm wide; pustules convex, laminal, usually scattered, very rarely crowded; soralia laminal, submarginal or marginal, laminal and submarginal soralia subpustulate-capitate, arising from convex pustules (0.1) 0.5–2.0(3.0) mm; marginal soralia convex, labriform, usually absent on young lobes but always present on older lobes; soredia farinose. Lower surface black in the center, rhizinate, but brown or white at the margins, erhizinate at the lobe apices, pustulate; pustules concave, usually white within or very rarely black, (0.1)0.5–2.0(3.0) mm wide. Apothecia very rare, laminal, subpedicellate, up to 6 mm wide; mature disc weakly concave, smooth, brown; thalline exciple pseudocyphellate; pseudocyphellae projecting slightly, soredia absent; margin thin. Ascospores broadly ellipsoid to subglobose, 12–16 × 10–12 µm. Pycnidia not seen.

Chemistry: Cortex K+ yellow; medulla C+ rose, KC+ pinkish to rose; containing atranorin [minor], imbricaric acid [major], perlatolic acid [minor], divaricatic acid [minor], anziaic acid [minor], 4-*O*-demethylimbricaric acid [minor], glomelliferic acid [trace] and loxodellic acid [trace].

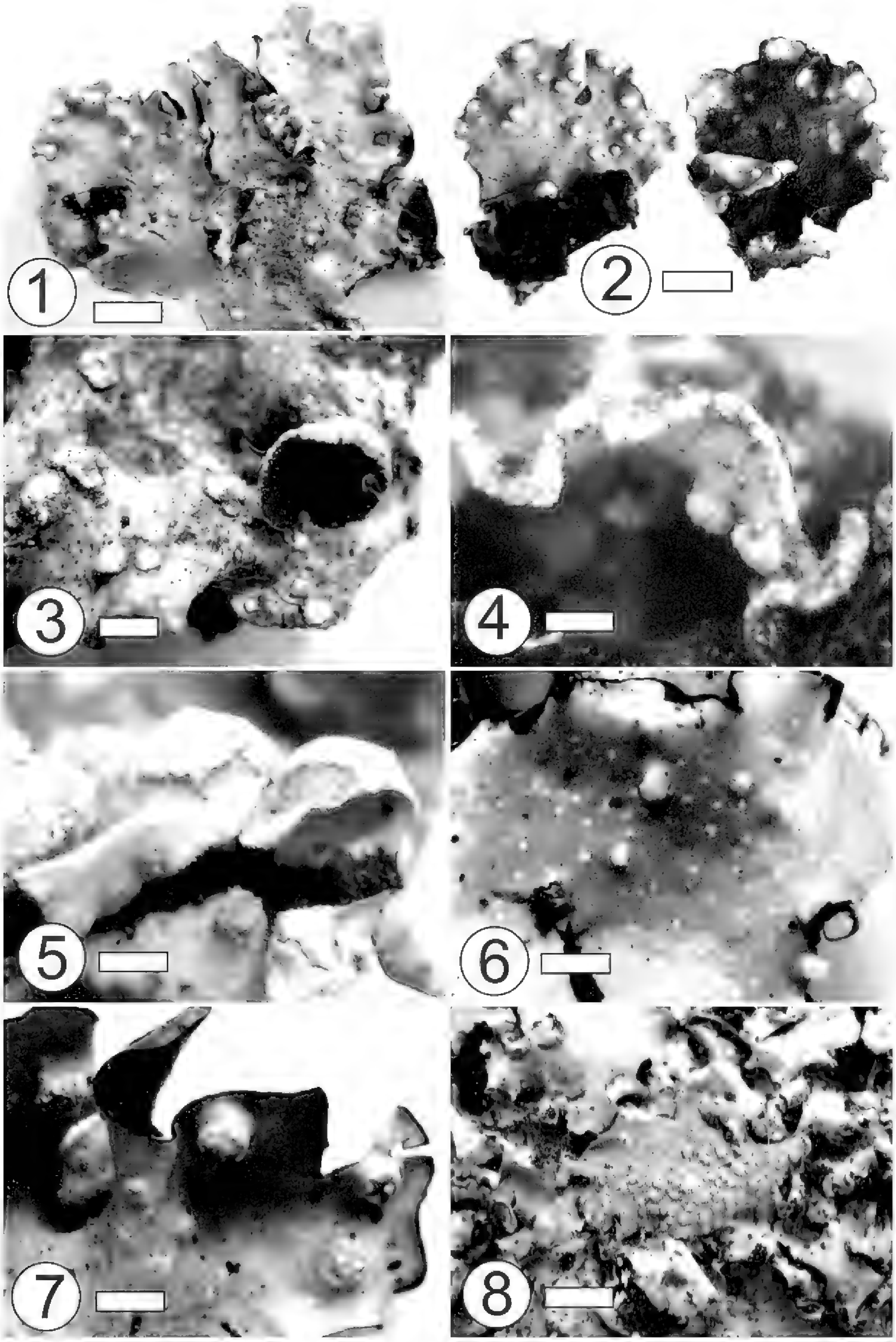
Paratypes—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, 52°55'–53°04'N, 92°57'–93°15'E: Kulumys Ridge, Maralii Stream, 440 m alt., on *Salix rorida*, N.V. Stepanov, 15 Jul. 2005 (KRSU); Tchebizhek River, middle part, 930 m alt., on *Sorbus sibirica*, N.V. Stepanov, 24 May 2007 (KRSU); Tchebizhek River, lower part, 405 m alt., on *Sorbus sibirica*, N.V. Stepanov, 17 Jun. 2007 (KRSU), ibid., 21 Jul. 2008 (KRSU); Kulumys Stream, 800 m alt., on old branches of *Abies sibirica*, T.N. Otnyukova, 24 Jul. 2007 (KRF); Bagazyul River, 500 m alt., on *Salix rorida*, N.V. Stepanov, 16 Jul. 2008 (KRSU); Bolschoi Kebezh River basin, Krutoi Klyuch Stream, 410 m alt., on *Betula platyphylla*, N.V. Stepanov, 16 Jul. 2007 (KRSU); Staroverskii Stream, 400 m alt., on *Betula platyphylla*, N.V. Stepanov, 17 Jul. 2008 (KRSU); Kedranskii Ridge, Krutoi Klyuch Stream, 410 m alt., on *Abies sibirica*, N.V. Stepanov, 18 Jul. 2008 (KRSU).

Comments—This new species is similar to the sorediate *Cetrelia* species, *C. cetrarioides* (Delise ex Duby) W.L. Culb. & C.F. Culb., *C. chicitae* (W.L. Culb.) W.L. Culb. & C.F. Culb., *C. olivetorum* (Nyl.) W.L. Culb. & C.F. Culb., and *C. monachorum* (Zahlbr.) W.L. Culb. & C.F. Culb., but it differs from the all of these species in having pustulate-capitate soralia. In addition, *C. monachorum* has a thicker thallus (200–300 µm vs. 130–180 µm in *C. sayanensis*), while *C. cetrarioides* has labriform marginal soralia (marginal soralia more convex and appearing labriform-capitate in *C. sayanensis*). The chemistry of *C. sayanensis* is identical to some specimens of *C. monachorum*.

The pustulate-capitate soralia of *C. sayanensis* could be confused with the laminal, capitate soralia present in *C. cetrarioides* and *C. monachorum* (Obermayer & Mayrhofer 2007) and *C. olivetorum* (Randlane & Saag 1992), which are usually very rare but may be quite dense on the upper surface of older thalli. The development of such laminal, capitate soralia is often initiated within the pseudocyphellae on the upper surface and might be caused by an aging effect or other exogenous or endogenous factors (Obermayer & Mayrhofer 2007).

In Siberia such laminal, capitate soralia were found in *C. monachorum* together with mature apothecia and structures that appear to be primordia of apothecia; such soralia are typically crowded on one older lobe and absent on neighbouring lobes (Fig. 8). The pustulate-capitate soralia present in *C. sayanensis* are derived from scattered dull white maculae on the upper surface which develop into small round, convex pustules and differ markedly from the surrounding irregular shaped, flat, pseudocyphellae (Fig. 6). These pustules ultimately erupt into (3)5–8 petal-like flaps (Fig. 7).

At present, *C. sayanensis* is known from the bark of *Abies*, *Betula*, *Salix* and *Sorbus* from several neighboring localities in the West Sayan Mountains at 400–930 m altitude.



FIGURES 1-8. *Cetrelia* species. 1-7. *C. sayanensis* (holotype in KRF). 1. Part of the holotype. 2. View of thalli, upper surface (left), lower surface (right). 3. Thallus with apothecia. 4. Marginal soralia and subpustulate-capitate soralia. 5. Subpustulate-capitate soralia. 6. Maculae developing into convex pustules in contrast to surrounding flat, irregular pseudocyphellae. 7. Erupting pustules with petal-like flaps. 8. *Cetrelia monachorum* (KRF), laminal capitate soralia on old part of thallus. Scale bars: 1, 2, 8 = 5 mm; 3 = 2.5 mm; 4-7 = 1 mm.

Myelochroa sayanensis Otnyukova, Stepanov & Elix, sp. nov. Figs 9–11
MycoBank MB 512979

Diagnosis: *Sicut* Myelochroa metarevoluta *sed thallus diminutus et irregularus, lobis angustioribus et acidum leucotylicum continente differt.*

typus—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Tanzibeiskaya Hollow, Malyi Kebesh River, 53°10'N, 92°57'30"E, Tanzybeika locality, 340 m alt., on bark of old *Padus avium*, N.V. Stepanov & T.N. Otnyukova, 13 Jun. 2007 (**holotype**–KRF; isotypes–KRSU, LE).

etymology: the specific epithet derives from the Latin *-ensis* (place of origin) and the the type locality, the Sayan Mountains in southern Siberia.

Thallus irregularly foliose or consisting of scattered lobes, loosely adnate, very small, 3–8(12) mm wide, thalli often coalescing into irregular patches 2–5 cm wide. Lobes sublinear to subirregular, flat, apically subtruncate, 0.1–0.8 (1.2) mm wide; margin ciliate, cilia dense, simple or sparsely branched, regularly dispersed, to 0.5 mm long. Upper surface grayish-white, margins black due to the projecting lower surface, slightly shiny, smooth, sorediate; soralia subpustulate or pustulate-capitate, laminal or submarginal near lobe apices, rarely helmet-like, soredia farinose. Medulla white, medullary hyphae forming 2–4-celled, bead-like chains, cells (6)8–10 µm diam. Lower surface black or mid-brown towards the lobe apices, rhizinate to the margins; rhizines dense, black, simple or rarely furcate, 0.5–1.5 mm long, often conspicuous and projecting beyond the margins. Apothecia common, 0.5–1.5(2.5) mm wide; disc pale brown, flat; thalline exciple thin, smooth, esorediate; margin thin, esorediate or very rarely sparsely sorediate. Ascospores ellipsoid, 8–12 × 5–8 µm. Pycnidia not seen.

Chemistry: Cortex K+ yellow then red-brown; medulla K+ yellow then red-brown, P+ yellow; containing atranorin [major or minor], chloroatranorin [trace], galbinic acid [major], salazinic acid [minor], norstictic acid [trace], secalonic acid W [trace], leucotylic acid [major], zeorin [major].

Paratypes—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, 52°55'–53°04'N, 92°57'–93°15'E: Tanzibeiskaya Hollow, Tanzybeika River (Vtoroye Koltso), 340 m alt., on bark of old *Padus avium*, N.V. Stepanov, 9 May 2008 (KRSU); Bolshoi Kebezh River basin, Maramzina Stream, 350 m alt., on old bark of *Padus avium* stem, N.V. Stepanov & T.N. Otnyukova, 15 Aug. 2008 (KRF, KRSU), Maramzina Stream, 350 m alt., on bark of *Padus avium*, N.V. Stepanov, 26 Aug. 2008 (KRSU).

Comments—This is the smallest species of *Myelochroa* and is invariably fertile, with lobes as short as 3 mm long bearing apothecia. In Siberia even juvenile specimens of *M. sibirica* (see below) and *M. metarevoluta* form small, ±rosette-like thalli, whereas in *M. sayanensis* the thalli are always irregular, mainly with irregularly branched, sublinear-elongate lobes. Furthermore, *M. metarevoluta* contains leucotylin and associated triterpenes rather than leucotylic acid. The subpustulate soralia and medullary chemistry resemble those of *M. sibirica* and

M. upretii Divakar & Elix, but those species have much larger thalli and broader lobes (see discussion under *M sibirica* below).

At present *M. sayanensis* is known only from the bark of *Padus avium* from several neighboring localities in the West Sayan Mountains at 340–350 m altitude.

Myelochroa sibirica Otnyukova, Stepanov & Elix, sp. nov. FIGS 12–15
MYCOBANK MB 512980

DIAGNOSIS: *Sicut* Myelochroa upretii *sed thallus diminutus, lobis angustioribus ad apicibus appressus et medulla albidus differt.*

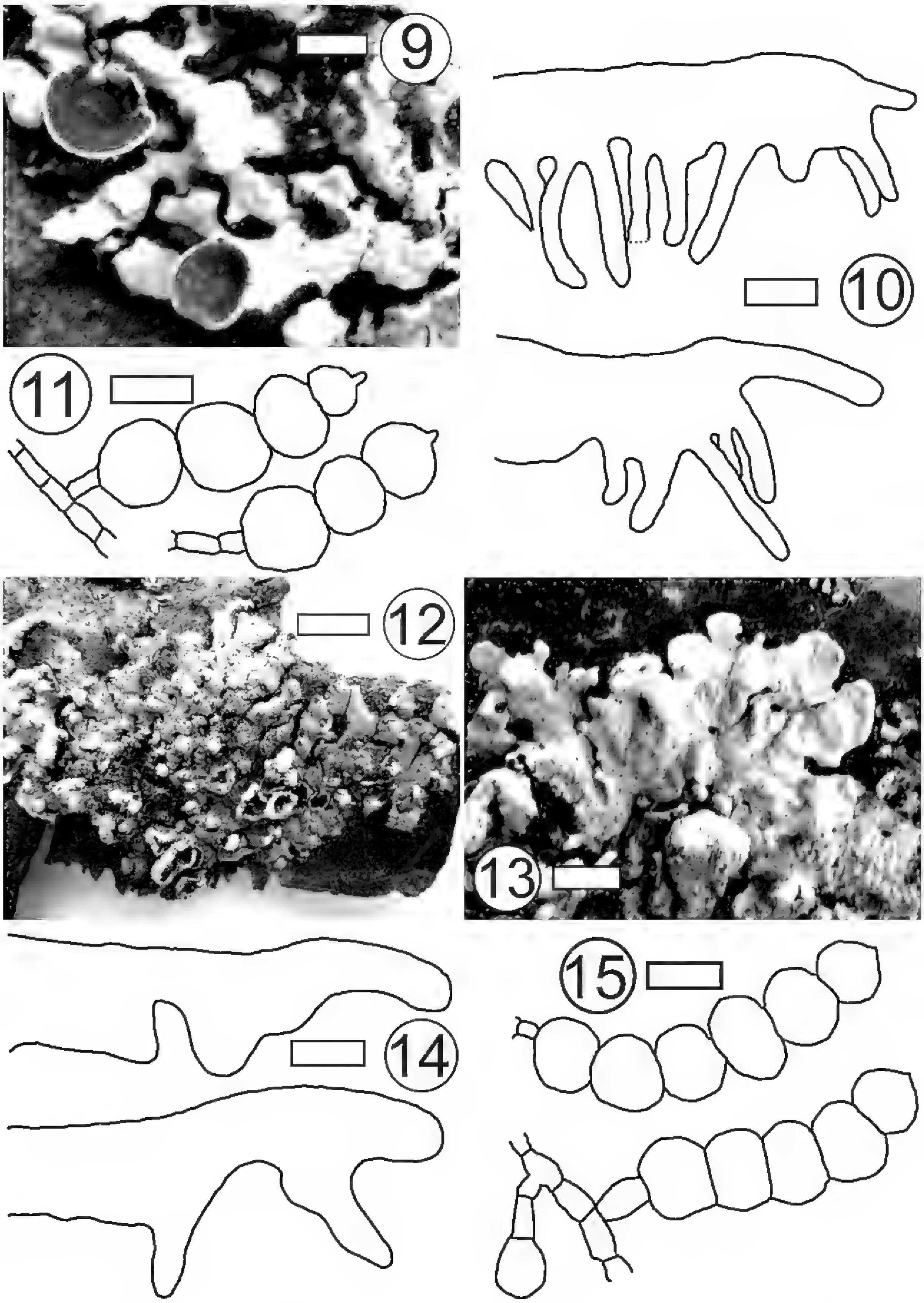
TYPUS—Russia, Krasnoyarsk Region, southern Siberia, West Sayan Mountains, Malii Kebezh River basin, Filin Klyuch Stream, 53°01’30”N, 92°58’30”E, 480 m alt., on bark of stem, branches and young twigs of *Padus avium*, T.N. Otnyukova & N.V. Stepanov, 14 Jul. 2004 (**holotype**–KRF; isotypes–KRSU, LE).

ETYMOLOGY: the epithet derives from the occurrence of this species in Siberia.

THALLUS foliose, irregular, tightly adnate, 1–4 cm wide. LOBES convex, regularly or irregularly branched, apically subrotund or subrotund and incised, 1–3(5) mm wide; marginal lobes convex and appressed to the substratum; margin eciliate or very sparsely ciliate. UPPER SURFACE greenish-gray to greenish-white, dull, becoming shiny at apices, becoming rugose with age, sorediate. SORALIA subpustulate or pustulate-capitate, submarginal but spreading laminally, very rarely helmet-like, originating at the apices; soredia granular. MEDULLA white, sometimes pigmented red in soralia and exposed cracks in the upper cortex; medullary hyphae forming 2–6-celled, bead-like chains, cells 6–8 µm diam. LOWER SURFACE black, brown in a narrow marginal, erhizinate zone; RHIZINES relatively dense, black, simple, not furcate or projecting beyond the lobe margins. APOTHECIA common, 1.5–4.0 mm wide; disc brown, markedly concave with age, inner margin convolute; thalline exciple sorediate; margin thin or thick, invariably sorediate. ASCOSPORES ellipsoid, 10–12 × 6–8 µm. PYCNIDIA not seen.

CHEMISTRY: Cortex K+ yellow then red-brown; medulla K+ yellow then red-brown, P+ yellow; containing atranorin [major or minor], chloroatranorin [trace], galbinic acid [major], salazinic acid [minor], norstictic acid [trace], secalonic acid W [trace], leucotylic acid [major], zeorin [major].

PARATYPES—Russia, Krasnoyarsk Region. Southern Siberia, West Sayan Mountains, 53°04’–53°10’N, 92°57’–93°07’E: Tanzibeiskaya Hollow, Tanzybeika River (Vtoroye Koltso), 340 m alt., on bark of *Salix rorida*, N.V.Stepanov, 15 Jul. 2008 (KRSU); Bolshoi Kebezh River basin, Krutoi Klyuch Stream, 410 m alt., on bark of *Salix rorida*, N.V.Stepanov, 17 Jul. 2007 (KRSU); Maramzina Stream, 350 m alt., on bark of stem, branches and young twigs of *Padus avium*, N.V.Stepanov & T.N. Otnyukova, 15 Aug. 2008 (KRF, KRSU); Kulumys Ridge, Aleev Stream, 405 m alt., on bark of *Salix rorida*, N.V.Stepanov, 18 Jul. 2008 (KRSU).



FIGURES 9–15. New species of *Myelochroa*. 9–11. *M. sayanensis* (holotype in KRF); 9. Thallus with apothecia; 10. Cross sections of thallus, margins with cilia and rhizines; 11. 3–4-celled hyphal chains. 12–15. *M. sibirica* (holotype in KRF); 12. Thallus with apothecia; 13. Lobes of thallus; 14. Cross sections of thallus, margins lacking cilia and rhizines; 15. 5–6-celled hyphal chains.

Scale bars: 9 = 1 mm; 10, 14 = 250 µm; 11, 15 = 10 µm; 12 = 5 mm; 13 = 2.5 mm.

COMMENTS–*Myelochroa sibirica* most closely resembles *M. upretii* from India (Divakar et al. 2001) as both have subpustulate soralia and similar medullary chemistry, but it differs in having smaller thalli (1–4 cm vs. 7–11 cm wide), narrower lobes (1–6 mm vs. 2–10 mm wide), in the subpustulate soralia spreading laminally (vs. mainly marginal in *M. upretii*), and in the white medulla (pale yellow in patches in *M. upretii*). *Myelochroa sibirica* differs both chemically and morphologically from *M. metarevoluta*, which also occurs in Siberia. Thus, *M. metarevoluta* has capitate soralia on ascending lobe apices and 8-celled hyphal chains whereas *M. sibirica* has subpustulate soralia on lobes appressed at the apices and 2–6-celled hyphal chains. Although both *M. metarevoluta* and *M. sibirica* contain galbinic acid as a major constituent, *M. metarevoluta* contains leucotylin and associated triterpenes rather than leucotylic acid.

At present, *M. sibirica* is known from the bark of *Padus* and *Salix* species from several neighbouring localities in the West Sayan Mountains at 340–480 m altitude.

Acknowledgements

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Revision of *Termitomyces* in China

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Abstract — A survey of *Termitomyces* was carried out to clarify the species in China based on examination of more than 600 specimens, of which one third were fresh material collected from the field in this study. Among 32 Chinese records, including 26 in *Termitomyces* and six in *Sinotermitomyces*, the distribution of 11 species in China, viz. *T. aurantiacus*, *T. bulborhizus*, *T. clypeatus*, *T. entolomoides*, *T. eurrhizus*, *T. globulus*, *T. heimii*, *T. mammiformis*, *T. microcarpus*, *T. striatus* and *T. tylerianus*, is recognized, whilst seven are excluded because of misidentification or misapplied names, and five are unconfirmable owing to the lack of specimen support. There are nine synonyms of other known *Termitomyces* species, eight of which were described as new species from China. The recognized Chinese species are described in detail with discussion on their morphological variation. A key to the Chinese species is provided and discussion on other Chinese records made.

Keywords — *Agaricales*, taxonomy, *Lyophyllaceae*

Introduction

Termitomyces is an agaric genus cultivated by termites, with basidiomata growing in association with termite nests. The relationship between *Termitomyces* and termites is mutualistic or symbiotic (Batra & Batra 1966, 1967, 1979, Batra 1975, Heim 1977, Bels & Pataragetivit 1982, Shaw 1992). The colonies of *Termitomyces* are managed by termites in their nest as "fungus gardens" and in return the fungi degrade lignin and cellulose of plant material for termites as food. In addition, *Termitomyces* fungi also provide other substances, e.g. enzymes and vitamins that are vital to the life of termites (Batra & Batra 1967, 1979). Species of *Termitomyces* are edible and sought after (Oso 1975, Parent

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& Thoen 1977, Ogundana & Fagade 1981, Purkayastha 1985, Sangvichien & Taylor-Hawksworth 2001) and highly priced in the markets, e.g. US$6.5/kg in local markets of Chiang Mai, Thailand in 1994 (Jones et al. 1994) and US$25/kg (RMB¥200/kg) in Kunming, Yunnan, China in 2006 (this study).

Termitomyces is a monophyletic clade in *Agaricales* (Moncalvo et al. 2000, Aanen et al. 2002, Rouland-Lefevre et al. 2002, Frøslev et al. 2003) and should be placed in *Lyophyllaceae* Jülich based on molecular phylogenetic analyses (Matheny et al. 2007). *Termitomyces* is also very distinct for its symbioses and co-evolution with species of *Macrotermitinae* Kemner (*Isoptera*). About 330 termites can establish symbiotic relationships with *Termitomyces* species (Mueller & Gerardo 2002), mainly *Macrotermes* Holmgren, *Microtermes* Wasmann and *Odontotermes* Holmgren (Batra & Batra 1966, 1979, Batra 1975, Heim 1977, Zang 1981a, Thomas 1985). In recent studies, it was determined that the fungus-growing termites originated in African rainforests (Aanen & Eggleton 2005) and that termite-*Termitomyces* symbiosis is also of single African origin (Aanen et al. 2002).

Currently, 81 names based on 68 taxa have been published under *Termitomyces* worldwide, of which 40 were accepted in the Dictionary of the Fungi (Kirk et al. 2001). The genus is distributed widely from equatorial and southern Africa to southern and southeastern Asia, including southern China (Heim 1942, 1977, Otieno 1966, 1969, Pegler 1977, Batra & Batra 1979, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994, Wei & Yao 2003). The species, with few exceptions, can be easily recognized by their prominent perforatorium, long subterranean pseudorhiza, pinkish basidiospore deposit and non-amyloid basidiospores (Heim 1942, 1977, Pegler 1977). Compared with other agarics, the genus has a wide range of morphological differentiation among species. *Termitomyces titanicus* Pegler & Piearce, for example, forms the largest agaric basidiomata in the world with a pileus more than 1 m diam. (Piearce 1987), whilst that of *T. microcarpus* rarely exceeds 2.5 cm diam. (Heim 1977, Pegler & Vanhaecke 1994).

Since *Termitomyces* was proposed by Heim (1942), numerous taxa have been documented from Africa (e.g. Heim 1941, 1942, 1951, 1952, 1958, Otieno 1966, 1969, Reid 1975, Pegler 1977, Pegler & Piearce 1980, Van der Westhuizen & Eicker, 1990, Saarimäki et al. 1994, Mossebo et al. 2002) and the research on Asian species has also been carried out by Natarajan (1976, 1977, 1979), Sathe & Daniel (1981), Sathe & Deshpande (1981), Natarajan & Raman (1981), Natarajan & Purushothama (1986), Dhancholia et al. (1991), Pegler & Vanhaecke (1994), Wei & Yao (2003), Wei et al. (2003, 2004, 2006) and Tang et al. (2006a, b). There are five species of *Termitomyces* reported from Central America (Gómez 1995), but their taxonomic status remains uncertain because

the region is obviously beyond the established distribution of *Macrotermitinae* species.

The generic status of *Sinotermitomyces* was queried by Pegler & Vanhaecke (1994) and Frøslev et al. (2003) based on either morphological or molecular evidences. Five species of *Sinotermitomyces* (including type species, *S. cavus*) have proved to be synonyms of *Termitomyces* species based on the study of their type material and the two genera are confirmed as congeneric (Wei et al. 2006).

Termitomyces species in China was first reported by Cheo (1942) under the name "*Collybia albuminosa* (Berk.) Petch" (Wei & Yao 2003) and further description of the genus was then provided by Teng (1963) in Chinese. *Termitomyces* species with correct generic name were first recorded from Fujian by Huang (1973), and then Zang (1981a) reported three species from Yunnan, including two new records. Subsequently, more *Termitomyces* taxa, with four new species, were reported by He (1985), Zhang & Ruan (1986), Yang (1990), Yang & Shuai (1990), Ying & Zang (1994), Yuan & Sun (1995), Mao (2000), Wang & Liu (2002) and Wei et al. (2004). To clarify *Termitomyces* species in China, all specimens of the genus deposited in major Chinese fungal herbaria were examined and additional specimens were collected from field work over recent years. The results of this study are reported here. Eleven species of *Termitomyces* are recognized from China and fully described with comments on their identification and distribution in this paper. Conclusions on the previously reported taxa (including six *Sinotermitomyces* species) are also summarized, together with provision of a key to the recognized species in China.

Materials and methods

More than 400 specimens of *Termitomyces* species deposited in three fungal herbaria in China, i.e. the Fungal Herbarium, Institute of Microbiology, Chinese Academy of Sciences (also as Herbarium Mycologicum Academiae Sinicae, HMAS), the Herbarium of Cryptogams, Kunming Botanic Institute, Chinese Academy of Sciences (HKAS) and the Herbarium of Institute of Microbiology, Guangdong (HIMGD), representing almost all the collections of the genus in China, were examined. In addition to the existing exsiccata, extensive field work was carried out by this group from 2002 to 2005 and more than 200 fresh collections of the genus were obtained and used for this study.

The fresh basidiomata were carefully examined by removing the soil on the surface of pseudorhiza and the macro-morphological characters were recorded in detail before oven drying at about 45°C. Tissue preservation in silica gel and living strain isolation were also performed in the field for molecular work and

for other further studies (results not reported here). The microscopic characters of all the dried specimens were examined. Thin sections were prepared by hand, using a razor-blade. The sections of dried basidiomata, including lamellae, cutis, pileal context and partial veil, were mounted in 5 % KOH solution. Size range of basidiospores, basidia, tramal hyphae, pileal context and cutis were measured using an ocular micrometer. At least 30 basidiospores and 20 basidia of each mature specimen were measured.

Descriptions of the specimens on loan from herbaria were mainly based on the dried material including the original collection records. Some herbarium specimens were in bad condition and the species identity could not be determined. They are not cited in this paper.

Taxonomy

Termitomyces R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 147 (1942).

= *Rajapa* Singer, Lloydia 8: 142 (1945) (see Singer 1946).

= *Podabrella* Singer, Lloydia 8: 143 (1945) (see Pegler 1977, Gomez 1995).

= *Sinotermitomyces* M. Zang, Mycotaxon 13: 171 (1981) (see Wei et al. 2006).

Type: *Schulzeria striata* Beeli, Bull. Jard. Bot. État. 15: 29 (1938).

Basidiomata small to large. Pileal surface white to colored, usually paler toward margin; smooth or coarse, squamulate or smooth, rimose radially; margin striate, often splitting radially when mature, usually with protruding perforatorium, but absent or indistinct in a few species. Lamellae free, white at first, becoming cream or pinkish when mature; crowded, with lamellulae. Stipe central, usually cylindrical and more or less thickening close to the ground; surface white, smooth or squamulate; annulate or not; solid, fibrous, consisting of longitudinally parallel thin-walled hyphae. Pseudorhiza mostly present, rarely absent; tapering or cylindrical, connected to termite combs; surface pale or dark colored, striate; solid or hollow, fibrous, leathery or cartilaginous. Partial veil present or not, membranous if present; ephemeral in most species, and sometimes persisting as an annulus and squamules. Context white, fleshy, of thin-walled, inflated hyphae. Basidiospore deposit pinkish or cream. Basidiospores ovoid to ellipsoid; surface smooth; thin-walled and subhyaline; inamyloid. Basidia clavate, thin-walled and subhyaline with 4 sterigmata. Cystidia present or not, usually clavate to pyriform, few fusiform; rarely septate; smooth; thin-walled and hyaline. Clamp-connections absent.

In addition to 24 taxa previously reported from China (Wei & Yao 2003), one new species, *T. bulborhizus*, and one new Chinese record, *T. entolomoides*, were reported during this investigation (Wei et al. 2003, 2004). A total of 26 taxa of *Termitomyces* have been reported from China and another six were

described under *Sinotermitomyces*. All of these taxa are listed in Table 1 with their current status indicated. There are 11 species recognized in China with nine synonyms, seven excluded because of misidentification or misapplied name, and five unconfirmed records owning to the lack of specimen support. The recognized species are described below and included in the key, whilst the records of synonyms and of misapplied names are discussed under their correct names.

Key to *Termitomyces* species recognized in China

1a. Basidioma small, with pileus less than 4.5 cm diam. when mature 2
1b. Basidioma medium to large, with pileus more than 4.5 cm diam. when mature... 3

2a. Basidioma growing from debris of comb carried to ground surface by termites, without pseudorhiza; pileus with small and bluntly pointed perforatorium .... ***T. microcarpus***
2b. Basidioma arising from comb surface, with elongated pseudorhiza; pileus with sharply pointed perforatorium .... ***T. tylerianus***

3a. Basidioma medium-size, pileus usually less than 10.0 cm diam.; pseudorhiza surface white, cream or pale greyish 4
3b. Basidioma large, pileus usually more than 12.0 cm diam.; pseudorhiza surface pale or dark colored 9

4a. Partial veil forming persistent, double-ringed annulus plus squamules on both pileal and stipe surface; pseudorhiza hollow, leathery 5
4b. Partial veil none or ephemeral, forming neither an annulus nor persistent squamules; pseudorhiza solid, fibrous 6

5a. Perforatorium obtuse, coarse but non-scrobiculate .... ***T. heimii***
5b. Perforatorium mammiform, scrobiculate or alveolate............ ***T. mammiformis***

6a. Pileal surface black; stipe surface pale grey, with fine flocci .... ***T. entolomoides***
6b. Pileal surface white to brown; stipe surface white, smooth and glabrous..........7

7a. Perforatorium distinctly pointed, sharp spiniform .... ***T. clypeatus***
7b. Perforatorium only moderately pointed 8

8a. Pileal surface bright, golden, orange to reddish brown .... ***T. aurantiacus***
8b. Pileal surface white, or cream to greyish white....................... ***T. striatus***

9a. Stipe surface with persistent flocci, with a bulbous base; pseudorhiza pale, pale yellowish or pale brownish .... ***T. bulborhizus***
9b. Stipe surface smooth and glabrous, base thickening but non-bulbous; pseudorhiza dark, brown, reddish brown or black.......................................10

10a. Perforatorium bluntly pointed or obtuse; pileal margin straight to upcurved when mature; pseudorhiza covered by a black crust, cartilaginous .... ***T. eurrhizus***
10b. Perforatorium absent; pileal margin incurved or downwardly curved when mature; pseudorhiza brown or reddish brown.................... ***T. globulus***

TABLE 1. *Termitomyces* and *Sinotermitomyces* taxa reported from China.

TAXA	REFERENCES	CURRENT STATUS
Termitomyces albiceps	He (1985)	Synonym of *T. eurrhizus*
T. albuminosus (Berk.) R. Heim	Huang (1973)	*, synonym of *Leucocoprinus cepistipes*, misapplied to Chinese records, which possibly belong to *T. eurrhizus* or *T. clypeatus*
T. aurantiacus	Yang & Shuai (1990)	√
T. badius	Zhang & Li (1988)	Synonym of *T. microcarpus*
T. bulborhizus	Wei et al. (2004)	√
T. clypeatus	He (1985)	√
T. cylindricus	He (1985)	Synonym of *T. aurantiacus*
T. entolomoides	Wei et al. (2003)	√
T. eurrhizus	Bi (1986)	√
T. fuliginosus R. Heim	Zhang & Li (1988)	*, misidentification of *T. clypeatus* or *T. eurrhizus*
T. globulus	He (1995)	√
T. heimii	Yang (1990)	√
T. letestui (Pat.) R. Heim	Mao (2000)	*, without specimen support and the description does not coincide with that of Heim (1942)
T. macrocarpus	Zhang & Ruan (1986)	Synonym of *T. eurrhizus*
T. mammiformis	Mao (2000)	√
T. mammiformis f. *albus* R. Heim	Mao (2000)	**
T. medius R. Heim & Grassé	Bi et al. (1994)	*, misidentification of *T. microcarpus*
T. microcarpus	Zang (1981a)	√
T. radicatus Natarajan	Wang & Liu (2002)	**
T. robustus (Beeli) R. Heim	Zang (1981a)	*, misidentification of *T. bulborhizus* or *T. eurrhizus*
T. schimperi (Pat.) R. Heim	Mao (2000)	*, without specimen support and the description does not coincide with that of Heim (1942)
T. spiniformis R. Heim	Mao (2000)	**
T. striatus	Zhang & Li (1988)	√
T. striatus f. *griseus* R. Heim	Mao (2000)	**
T. striatus f. *ochraceus* R. Heim	Mao (2000)	**
T. tylerianus	Bi et al. (1990)	√
Sinotermitomyces carnosus	Zang (1981b)	Synonym of *T. mammiformis*
S. cavus	Zang (1981b)	Synonym of *T. heimii*
S. griseus	Zang (1992)	Synonym of *T. mammiformis*
S. meipengianus M. Zang & D.Z. Zhang	Zang & Zhang (2004)	*, not *Termitomyces*
S. rugosiceps	Zang (1992)	Synonym of *T. mammiformis*
S. taiwanensis	Zang & Chen (1998)	Synonym of *T. clypeatus*

√ Recognized in China.
* Excluded Chinese records of misidentification or misapplied name.
** Unconfirmed Chinese records lacking support of specimen citation.

Termitomyces aurantiacus (R. Heim) R. Heim, Term. et Champ.: 56 (1977).

≡ *Termitomyces striatus* var. *aurantiacus* R. Heim, Denkschr. Schweiz. Naturf. Ges. 80: 23 (1952).

= *Termitomyces cylindricus* S.C. He, Acta Mycol. Sin. 4: 104 (1985) (see Tang et al. 2006b).

Pileus 3.0–10.0(–14.0) cm diam., at first conical to convex, convexo-applanate to up-curved when mature, with a small and bluntly pointed perforatorium (up to 5 mm high); surface reddish brown at centre and paler toward margin, smooth, glabrous; margin applanate, finely striate and splitting radially. Lamellae free, white at first, becoming pinkish; up to 8.0 mm wide, crowded, with lamellulae. Stipe 2.0–10.0 × 1.3–1.6 cm, central, cylindrical or sometimes slightly thickening; surface white, smooth, glabrous; solid fibrous, hard after drying, composed of longitudinally parallel hyphae, thin-walled, hyaline, 2.0–15.0 µm diam. Pseudorhiza up to 34 cm long, 0.3–2.5 cm thick, cylindrical, rarely tapering, slender, terminal with a soft white column between inner wall of termite nest and comb; surface white, longitudinally striate; solid, fibrous, of thin-walled and hyaline hyphae, 2.0–20 µm diam. Partial veil membranous, ephemeral. Context white, up to 8.0 mm thick under perforatorium, of inflated thin-walled and hyaline hyphae, 2.5–8.0 µm diam., inflating to 30 µm. Basidiospore deposit pinkish. Basidiospores 5.5–8.0 × 3.5–5.5 µm, ovoid to ellipsoid; subhyaline, thin-walled. Basidia 16.0–24 × 5.5–8.5 µm, clavate, with four sterigmata; thin-walled and subhyaline. Lamella edge heterogeneous. Cheilocystidia 15.0–31 × 9.0–20 µm, clavate to pyriform, thin-walled, hyaline. Pleurocystidia not found. Hymenophoral trama 60–80 µm wide, regular, of thin-walled and hyaline hyphae, 5.0–20 µm diam. Subhymenial layer 10.0 µm wide, of branched hyphae, 2.0–5.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, 1.5–4.5 µm diam.

Specimens examined: CHINA: Yunnan: Mengla, Monglun Town, the Xishuangbanna Tropical Botanic Garden, 2 Sept 1990, Z.-L. Yang 1274 (HKAS 23291); ibid, 8 Aug 2003, G.-R. Hu and T.-Z. Wei W03-19 (HMAS 84720); ibid, 14 Aug 2004, B.-H. Tang T04103 (HMAS 86671); Jingdong, Phenix Mountains, alt. 1260 m, 25 Aug 1991, Z.-L. Yang 1642 (HKAS 23955); Menghai, 15 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 240 (HMAS 76623). Guizhou: Xingyi, Baiwayao Town, alt. 1530 m, on nest of *Macrotermes orthognathus* Ping & Xu, 22 Aug 1983, S.-C. He 1062 (HKAS 14695, paratype of *T. cylindricus*), S.-C. He 1061 (HMAS 47851, paratype of *T. cylindricus*).

Termitomyces aurantiacus is mainly characterized by the medium-sized basidiomata, orange to reddish brown pileus, small pointed perforatorium and white pseudorhiza. The species is similar to *T. striatus* but differs in the bright pileus and hard stipe. The description of *T. cylindricus* (He 1985) closely resembles that of *T. aurantiacus* although it was considered by He (1985) to differ from other *Termitomyces* species by having a cylinder at the pseudorhiza base. Examination of two paratype collections of *T. cylindricus* (HMAS 47851

and HKAS 14695) confirms it to be a synonym of *T. aurantiacus* (Tang et al. 2006b).

Termitomyces aurantiacus is widely distributed in equatorial Africa (Heim 1977) and Southeastern Asia (Pegler & Vanhaecke 1994), and was first recorded by Yang & Shuai (1990) in China based on the material from Xishuangbanna of Yunnan Province. The species was also reported in Sichuan and Guizhou (Ying & Zang 1994, Yuan & Sun 1995, Hu et al. 2000, Mao et al. 1993), but only the distribution in the south of Yunnan was confirmed in this study. *Termitomyces aurantiacus* symbioses with *Pseudacanthotermes militaris* (Hagen) in Africa (Pegler & Vanhaecke 1994) and with *M. orthognathus* in China (He 1985).

Termitomyces bulborhizus T.Z. Wei, Y.J. Yao, B. Wang & Pegler, Mycol. Res. 108: 1458 (2004).

Pileus (5.0–)10.0–22 cm diam., at first convex, convexo-applanate or even upwardly curved when mature, with a protruding, roundly obtuse perforatorium; surface reddish brown to dark brown at centre, elsewhere pale brown to brown, and paling toward margin, smooth or rough; margin straight to upcurved, striate, often splitting radially. Lamellae free, up to 8.0 mm wide, white at first, and pinkish when mature; crowded, with lamellulae. Stipe 3.0–12.5 × 0.8–6.0 cm, central, cylindrical above, expanding to 2.8–9.0 cm diam. at ground level and usually abruptly forming a prominently bulbous base below ground, robust; surface white above and pale brown on the bulb; with concolorous persistent floccules; solid, fibrous, composed of longitudinally paralleled hyphae, thin-walled and hyaline, 2.0–18.0 µm diam. Pseudorhiza up to 80 cm long, narrowing to 0.6–1.6 cm immediately below the bulb or tapering towards the base at the termite comb; surface white to pale brown, very rough, with longitudinal grooves and cracks; solid and fibrous, of subparallel, thin-walled hyphae, hyaline, 2.0–25 µm diam. Partial veil membranous, fragile and ephemeral. Context up to 2.0 cm thick, white, fleshy, composed of thin-walled and hyaline hyphae, 2.5–8.0 µm diam. in normal, inflating to 35 µm diam. Basidiospore deposit pinkish. Basidiospores 6.0–9.0 × 4.0–6.0 µm, ovoid to ellipsoid, thin-walled, subhyaline. Basidia 17.5–27 × 5.5–9.0 µm, clavate, bearing four sterigmata; thin-walled and subhyaline. Lamella-edge heterogeneous. Cheilocystidia 19.0–60 × 12.0–34 µm, clavate to pyriform; thin-walled and hyaline. Pleurocystidia 19.0–78 × 10.0–32 µm, clavate to pyriform, occasionally turbinate; thin-walled and hyaline. Hymenophoral trama 50–80 µm wide, regular, of thin-walled, hyaline hyphae, 3.5–20 µm diam. Subhymenial layer 10.0–25 µm wide, of branched and repent hyphae, 2.0–6.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, 1.5–7.0 µm diam., contain yellowish pigment.

Specimens examined: CHINA: Sichuan: Miyi, purchased in local market, 9 Aug 2002, B. Wang 200222 (HMAS 84444, holotype; K(M) 109284, isotype), B. Wang 200223

(HMAS 76813); ibid, 18 Aug 2002, B. Wang 200244 (HMAS 84445); ibid, 27 Aug 2002, B. Wang 200245 (HMAS 84528); Chengdu, purchased in local market, 5 Aug 2003, B. Wang 20031 (HMAS 77080); ibid, 12 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH323 (HMAS 77078); Dechang, purchased in local market, 13 Aug 2003, H. Teng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH329-1 (HMAS 79890), H. Teng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH327 (HMAS 86679); ibid, 14 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-38 (HMAS 86682); ibid, 15 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-39 (HMAS 86684); ibid, on nest of *Macrotermes barneyi* Light, 16 Aug 2003, T.-Z. Wei and L. Jiao W03-44 (HMAS 86687), T.-Z. Wei and L. Jiao W03-45 (HMAS 86685), T.-Z. Wei and L. Jiao W03-46 (HMAS 88328), T.-Z. Wei and L. Jiao W03-47 (HMAS 84729), Q.-B. Wang and S.-Z. Fu W03-49 (HMAS 79895), S.-Z. Fu and Q.-B. Wang W03-51 (HMAS 85225); Huidong, 16 Jul 1982, X.-C. Li 82016 (HKAS 13279); Mingshan, Mengshan Village, alt. 1000 m, 24 Jul 1984, M.-S. Yuan 1003 (HKAS 15836); Yanyuan, 14 Aug 1992, P.-G. Liu and M.-S. Yuan 1370 (HKAS 25792). Yunnan: Kunming, purchased in local market, 1 Aug 2003, T.-Z. Wei and Q.-B. Wang W03-1 (HMAS 86683), T.-Z. Wei and Q.-B. Wang W03-2 (HMAS 77079), T.-Z. Wei and Q.-B. Wang W03-3 (HMAS 86678); ibid, 24 Jul 2004, B.-H. Tang T0404-2 (HMAS 86662); Chuxiong, purchased in local market, 26 Jul 2005, T.-Z. Wei and F.-Q. Yu Gm 884 (HMAS 130151); Mengla, Menglun Town, Xishuangbanna Tropical Botanic Garden, 8 Aug 2003, G.-R. Hu and T.-Z. Wei W03-22 (HMAS 84717), G.-R. Hu and T.-Z. Wei W03-25 (HMAS 79893); ibid, 3 Aug 2004, B.-H. Tang, T0472 (HMAS 96508); ibid, 5 Aug 2004, B.-H. Tang and A.-Y. Li T0483 (HMAS 86677); ibid, 6 Aug 2004, A.-Y. Li and B.-H. Tang T0486 (HMAS 86664), M. Li and B.-H. Tang, T0496 (HMAS 96672); Jingdong, on nest of termite, 17 Jul 1978, D.-G. Ji (HKAS 4413); Cangyuan, on nest of termite, 30 Aug 1980, M. Zang (HKAS 6750); ibid, 31 Aug 1981, M. Zang (HKAS 6753); ibid, 4 Sept 1980, sin coll. (HKAS 6900); Luquan, 18 Aug 1980, Z.-F. Zhang 1 (HKAS 9427); ibid, alt. 1920 m, on nest of *Odontotermes formosanus* Shiraki, 19 Aug 1980, Z.-F. Zhang 3 (HKAS 9429), Z.-F. Zhang 2 (HKAS 9428); Pinglang, alt. 1800 m, 30 Aug 1985, M. zang (HKAS 14665); Puer, purchased in local market, 31 Aug 1990, Z.-L. Yang 1237 (HKAS 22981); Nanjian, Wuliang Mountains, alt. 2200 m, 12 Aug 2001, M. Zang 13857 (HKAS 38560), M. Zang 13857a (HKAS 38561). Guangxi: Nanning, alt. 180 m, 2 Aug 1999, P.-Q. Sun 4200 (HKAS 34770). Guangdong: Shixing, 3 Sept 1984, T.-H. Li (HMIGD 7944); ibid, alt. 370 m, 17 Aug 1985, T.-H. Li (HMIGD 8996).

Termitomyces bulborhizus was based on specimens from Sichuan and Yunnan and further collections have since been made. The extensive specimen citation above indicates that it is very common in the south and southwest of China. It is mainly distinguished by the large basidioma, bulbous stipe base and floccose stipe surface. Chinese herbarium specimens were often misidentified as *T. aurantiacus*, *T. globulus* and *T. robustus*. *Termitomyces bulborhizus* is associated with *O. formosanus* and *M. barneyi*, two common termite species in the south of China (Huang et al. 2000).

Termitomyces clypeatus R. Heim, Bull. Jard. Bot. État. 21: 207 (1951).

= *Schulzeria goossensiae* Beeli, Bull. Soc. Roy. Bot. Belg. 60: 75 (1927), pro parte (see Heim 1951).

= *Sinotermitomyces taiwanensis* M. Zang & C.M. Chen, Fung. Sci. 13: 25 (1998) (see Wei et al. 2006).

Pileus 2.5–10.0(–14.0) cm diam., firstly conical, then becoming convexo-applanate with distinctly protrudent and sharply spiniform perforatorium which 5–12 mm high; surface greyish brown, brown, greyish black or dark brown at centre, and paling toward margin, smooth and glabrous, radially rimose; margin decurved to straight, striate and splitting radially. Lamellae free, 3.0–7.0 mm wide, white to pinkish, crowded, with lamellulae. Stipe 4.0–13.0 × 0.5–1.8 cm, central, cylindrical, occasionally slightly thickening at ground level, slender; surface white, smooth and glabrous, striate; solid, fibrous, consisting of longitudinally parallel hyphae, thin-walled and hyaline, 2.0–15.0 µm diam. Pseudorhiza up to 22 cm long, cylindrical, sometimes tapering; surface white to pale yellow or pale grey, longitudinally striate; solid and fibrous, of subparallel hyphae, thin-walled and hyaline, 2.5–25 µm diam. Partial veil absent. Context 3.0–5.0 mm thick under perforatorium, white, fleshy, of inflated thin-walled hyphae, 2.0–7.0 µm diam., inflating to 30 µm. Basidiospore deposit pinkish. Basidiospores 6.0–9.0 × 4.0–6.0 µm, ovoid to ellipsoid, thin-walled, subhyaline. Basidia 15.0–28 × 5.5–9.0 µm, clavate, thin-walled, subhyaline, with four sterigmata. Lamella edge heterogeneous. Cheilocystidia 16.0–50 × 8.0–25 µm, clavate to pyriform, thin-walled and hyaline. Pleurocystidia 15.0–74 × 9.0–25 µm, similar to cheilocystidia. Hymenophoral trama 40–90 µm wide, consisting of thin-walled and hyaline hyphae, 4.0–20 µm diam. Subhymenial layer 10.0–16.0 µm wide, of branched and repent hyphae, 2.0–5.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, 2.0–5.0 µm diam.

Specimens examined: CHINA: Yunnan: Kunming, purchased in local market, 1 Aug 2003, T.-Z. Wei and Q.-B. Wang W03-4 (HMAS 77077), T.-Z. Wei and Q.-B. Wang W03-5 (HMAS 84712); ibid, purchased in local market, 24 Jul 2004, B.-H. Tang T0402-1 (HMAS 86672), B.-H. Tang T0402-2 (HMAS 86673); ibid, purchased in local market, 25 Jul 2004, B.-H. Tang T0405 (HMAS 98968); ibid, purchased in local market, 27 Jul 2004, B.-H. Tang T0414-2 (HMAS 98961), B.-H. Tang T0421-1 (HMAS 98962), B.-H. Tang T0414-1 (HMAS 98970), B.-H. Tang T0414 (HMAS 98986), B.-H. Tang T0415 (HMAS 98963), B.-H. Tang T0420-1 (HMAS 98978), B.-H. Tang T0420-2 (HMAS 98971), B.-H. Tang T0418-1 (HMAS 96503), B.-H. Tang T0418-2 (HMAS 98947), B.-H. Tang T0419-1 (HMAS 98984), B.-H. Tang T0419-2 (HMAS 86674); ibid, 26 Aug 2002, F.-Q. Yu 961 (HKAS 41725); ibid, 24 Aug 1997, X.-H. Wang 6 (HKAS 31686); ibid, 30 Jul 1999, X.-H. Wang 730 (HKAS 34486); Lufeng, 26 Jul 2004, B.-H. Tang T0413 (HMAS 96506); Xundian, Xiaodianwei Village, 26 Jul 2004, B.-H. Tang and W.-Y. Yang T0407 (HMAS 86670); Jinghong, on termite nest, Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 6 (HMAS 63363); Mengla, on groud in forest edge, 3 Sept 1974, M. Zang (HKAS 1187); ibid, 14 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 174 (HMAS 63527); ibid, 11 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 119 (HMAS 76755); ibid, Menglun Town, purchased in the local market, 7 Aug 2004, M. Li and B.-H. Tang T0488 (HMAS 86666), M. Li and B.-H. Tang T0487 (HMAS 86669); ibid, Menglun Town, Xishuangbanna Tropical Botanic Garden, alt. 580 m, 4 Aug 1988, Z.-L. Yang 263 (HKAS 21788); ibid, 29 May 1990, J.-G. Shuai 9 (HKAS 23269); ibid, 5 Aug 2004, A.-Y. Li and B.-H. Tang T0475 (HMAS 96502); ibid, 8 Aug 2004, M. Li and B.-H. Tang T0492 (HMAS 98982), M. Li and B.-H. Tang T0499 (HMAS 96491); ibid, 10 Aug 2004, M. Li and B.-H. Tang

T04105 (HMAS 98989); ibid, 11 Aug 2004, A.-Y. Li T04111 (HMAS 98969); Pingbian, 22 Jun 1974, X.-J. Li (HKAS 856); Luchuan, on termite nest in woodland, 16 Sept 1973, H. Huang 16 (HKAS 16); Ruili, Dengga Mountains, alt. 750 m, 14 Jul 1977, X.-J. Li 158 (HKAS 2988); ibid, 28 Jul 1979, W.-K. Zheng 79072 (HKAS 4842); Lianghe, 1 Aug 1977, X.-J. Li 313 (HKAS 3137); Tengchong, purchased in market of Gudong Town, 17 Sept 1996, P.-G. Liu Liu-96-3 (HKAS 30291), P.-G. Liu Liu-96-4 (HKAS 30295); ibid, 5 Aug 1977, X.-J. Li 509 (HKAS 3345); ibid, alt. 2000 m, 12 Aug 1977, X.-J. Li 705 (HKAS 3594); ibid, 15 Sept 1996, P.-G. Liu Liu-96-6 (HKAS 30292); ibid, 18 Sept 1996, P.-G. Liu Liu-96-7 (HKAS 30290); Yuanmou, alt. 1900 m, 3 Aug 1976, M. Zang (HKAS 5509); Mangshi, on termite nest, 10 Aug 1980, M. Zang (HKAS 6542); Longling, on termite nest, 10 Aug 1981, M. Zang (HKAS 6543); Lijiang, Aug 1980, X.-J. Li 81-6 (HKAS 7495); Luquan, alt. 1900 m, 9 Jul 1980, Z.-F. Zhang 4 (HKAS 9430); Gejiu, on termite nest, Jul 1982, D.-G. Ji 82-6 (HKAS 9738); Pinglang, alt. 1800 m, 11 Aug 1985, M. Zang 10387 (HKAS 14664); Jinning, 2 Sept 1985, X.-Z. Guo 85009 (HKAS 14705); Binchuan, Jizu Mountains, 17 Aug 1985, G.-P. Xiao 484 (HKAS 17235); Simao, Red Flag Reservoir, alt. 1400 m, 11 Sept 1986, K.-K. Chen 104 (HKAS 17670); ibid, Caiyang River, alt. 1500 m, 3 Jul 2000, M. Zang 13555 (HKAS 36484); Jingdong, Big Bell Mountains, alt. 1500 m, 24 Aug 1991, P.-G. Liu (HKAS 23953); Qujing, 20 Aug 1991, Z.-L. Yang (HKAS 23959); Jiangcheng, Niuluo River, alt. 1100 m, 8 Aug 1991, G. Song 105 (HKAS 23973); ibid, Jingdong Village, alt. 1400 m, 6 Aug 1991, Z.-L. Yang 1401 (HKAS 23975); Menghai, alt. 1170 m, 12 Aug 1997, M. Zang 12286 (HKAS 30637); Yuxi, purchased in local market, 1 Jul 1998, X.-H. Wang 314 (HKAS 32971); ibid, purchased from roadside, 22 Jul 2005, T.-Z. Wei, X.-H. Wang, H.-D. Zheng and H. Knudsen Gm 859 (HMAS 133284); Wuding, purchased in local market, 12 Aug 1999, X.-H. Wang 747 (HKAS 34487), X.-H. Wang 744 (HKAS 34489); Songming, Arziying Township, 5 Aug 2005, T.-Z. Wei and F.-Q. Yu Gm 1070 (HMAS 133282), T.-Z. Wei and F.-Q. Yu Gm 1071 (HMAS 130153), T.-Z. Wei and F.-Q. Yu Gm 1072 (HMAS 130147); Nanhua, purchased from local market, 28 Jul 2005, T.-Z. Wei and F.-Q. Yu Gm 958 (HMAS 130150). Sichuan: Xichang, purchased in local market, 8 Aug 2002, B. Wang 200221 (HMAS 77065); ibid, 27 Aug 1983, M.-S. Yuan 210 (HKAS 11806); ibid, 12 Aug 1992, P.-G. Liu and M.-S. Yuan 1362 (HKAS 25787), P.-G. Liu and M.-S. Yuan 1366 (HKAS 25785); ibid, alt. 1800 m, 19 Sept 1999, M. Zang 13150 (HKAS 34455), M. Zang 13150a (HKAS 34456); Muli, 29 Aug 1983, K.-K. Chen and L.-S. Wang 83-883 (HKAS 12556); ibid, alt. 2500 m, 17 Aug 1992, P.-G. Liu and M.-S. Yuan 1390 (HKAS 25788); ibid, alt. 2300 m, 19 Aug 1992, P.-G. Liu and M.-S. Yuan 1476 (HKAS 25797); Huidong, Aug 1982, Science Committee of Huidong County (SCHC) 82024 (HKAS 13271), SCHC 82026 (HKAS 13272), SCHC 82015 (HKAS 13273); ibid, 29 Jul 1982, SCHC 82020 (HKAS 13274), SCHC 82021 (HKAS 13275); ibid, 22 Jul 1982, SCHC 82022 (HKAS 13276); ibid, 12 Jul 1982, X.-C. Li 82012 (HKAS 13277); ibid, 11 Jul 1982, X.-C. Li 82011 (HKAS 13278); ibid, 14 Jul 1982, X.-C. Li 82014 (HKAS 13280), X.-C. Li 82018 (HKAS 13281); ibid, 10 Jul 1982, X.-C. Li 82012 (HKAS 13282), X.-C. Li 82023 (HKAS 13283); Miyi, alt. 800 m, 24 Jul 1986, M.-S. Yuan 1147 (HKAS 18400); Meigu, alt. 1700 m, 27 Aug 1992, P.-G. Liu and M.-S. Yuan 1506 (HKAS 25789); Dechang, purchased in local market, 19 Jul 2002, B. Wang 20021 (HMAS 84514), B. Wang 20022 (HMAS 84520); ibid, 31 Jul 2002, B. Wang 200212 (HMAS 84522), B. Wang 200213 (HMAS 76901), B. Wang 200215 (HMAS 83594); Shuangliu, purchased in local market, 12 Aug 2002, B. Wang 200225 (HMAS 76906); Pujiang, 18 Aug 2002, B. Wang 200231 (HMAS 76905), B. Wang 200236 (HMAS 76907). Guangxi: Baise, alt. 200 m, 30 Aug 1999, M.-S. Yuan 4169 (HKAS 34795). Guangdong: Fengkai, alt. 380 m, 13 VI 1986, Z.-S. Bi and G. Li (HMIGD 10183).Hainan: Changjiang, Bawang Mountains Nature Reserve, alt. 1010–1050 m, on termite nest in mixed forest, 15 Aug 1988, J.-L.

Ying (HMIGD 14201); ibid, 5 Aug 1987, Q. Chen (HMIGD 12104); Ledong, Heaven Lake in Jianfengling Mountains, alt. 800 m, on nest of *Microtermes obesi* Holmgren, 22 Jul 1981, M.-Q. Gong 108 (HKAS 22362). Fujian: without details of locality, 17 Aug 1986, C.-Y. Chen (HKAS 17653). Taiwan: Taizhong, Dongshi Forestry Centre, 9 Aug 1995, C.-M. Chen 840369 (HKAS 30318); Nantou, Zhongxing Village, 13 Jul 1997, C.-M. Chen C1900 (HKAS 30524, holotype of *S. taiwanensis*).

Termitomyces clypeatus can be easily recognized by its sharp spiniform perforatorium, together with the slender habit and pale colored pseudorhiza. The species is similar to *T. aurantiacus* and *T. striatus* in the medium-sized basidiomata, pointed perforatorium and whitish pseudorhiza. However, the perforatorium of the latter two are obviously smaller and more obtuse (no more than 5 mm high) than that of *T. clypeatus* (5–12 mm high). Moreover, *T. clypeatus* lacks a partial veil, but *T. aurantiacus* and *T. striatus* have a membranous and fragile partial veil, although it is usually absent at maturity.

Termitomyces clypeatus was often misidentified as "*Termitomyces albuminosus* (Berk.) R. Heim" in Chinese records in the past (e.g. Zang 1981a, Ying & Zang 1994, Yuan & Sun 1995), whilst *S. taiwanensis* was confirmed as a synonym of *T. clypeatus* based on examination of the holotype (Wei et al. 2006).

Termitomyces clypeatus is widely distributed in Africa and Asia (Heim 1977, Pegler 1977, Pegler & Piearce 1980, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994, Turnbull & Watling 1999) and a common species in the south and southwest of China (He 1985, Ying & Zang 1994, Bi et al. 1994, Yun & Sun 1995). The species is reported symbiotic with *Macrotermes falcifer* (Gerstacker) and *Odontotermes* sp. in Zambia, Africa (Piearce 1987) and growing on nests of *Odontotermes* species, e.g. *O. grandiceps* Holmgren, *O. malaccensis* Holmgren and *O. sarawakensis* Holmgren in Southeastern Asia (Bels & Pataragetvit 1982, Pegler & Vanhaecke 1994). In China, *T. clypeatus* was found on nests of *O. formosanus* (He 1985), *M. orthognathus*, *M. barneyi* (Huang 1993) and *Microtermes obesi* (this study).

Termitomyces entolomoides R. Heim, Denkschr. Schweiz. Naturf. Ges. 80: 23 (1952).

Pileus 3.5–4.0 cm diam., plano-convex to finally concave, with a small, sharply pointed perforatorium; surface black at centre, elsewhere greyish black, slightly paling towards the margin, smooth, glabrous, striate radially; margin straight or upcurved, splitting. Lamellae free, white to pinkish, 3.0–4.0 mm wide, densely crowded, with lamellulae. Stipe 4.5–5.0 cm long above ground, 0.5–0.7 cm thick close to apex, cylindrical, but swollen at ground level, solid, fibrous; surface pale grey, with small floccules. Pseudorhiza 4.0–5.5 cm long, 1.5–1.7 cm thick close to ground level, tapering, with a white, cylindrical base connected with the termite nest; surface grey, with longitudinal grooves. Partial veil absent. Context white, fleshy, thin, comprised of repent, thin-walled hyphae, 3.0–7.0

µm diam, inflating to 35 µm diam. Spore deposit pink. Basidiospores 5.5–7.0 × 3.5–4.5 µm, ovoid to ellipsoid, subhyaline, thin-walled. Basidia 17.0–22 × 6.0–7.0 µm, clavate, bearing four sterigmata, subhyaline. Hymenophoral trama regular, 60–80 µm wide, with hyaline hyphae, 5.0–20 µm diam. Subhymenial layer 8.0–10.0 µm wide, consisting of repent hyphae, 2.0–5.0 µm diam. Lamella-edge heterogeneous. Cheilocystidia clavate to pyriform, 28–60 × 13.0–31 µm, thin-walled, hyaline. Pleurocystidia rare, clavate to pyriform, 23–41 × 9.0–26 µm, thin-walled, hyaline. Pileipellis a repent epicutis of narrow, radial hyphae with yellowish vacuolar pigment, 3.0–5.0 µm diam.

Specimen examined: CHINA: Guangdong: Huidong, Gutian, 400 m alt., on ground in broadleaf woodland, 11 Jul 1987, G.-Y. Zheng (HMIGD11367).

Termitomyces entolomoides is a taxon with small to medium-sized basidiomata (Pegler & Vanhaecke 1994, Wei et al. 2003). It was described by Heim (1952) based on African material and later reported from Southeastern Asia (Pegler & Vanhaecke 1994, Turnbull & Watling 1999). *Termitomyces entolomoides* was also reported from China recently (Wei et al. 2003), after a comparison of the Chinese collection with specimens of the species studied by Pegler & Vanhaecke (1994), and several other similar species, e.g. *T. aurantiacus*, *T. sagittiformis* (Kalchbr. & Cooke) D. A. Reid and *T. striatus*. The Chinese collection strongly resembles the three collections of *T. entolomoides* from Malaysia and Singapore cited by Pegler & Vanhaecke (1994), i.e. K(M) 16520, K(M) 94651 and K(M) 109534, but attempts with DNA isolation and amplification from these four collections proved unsuccessful owing to their poor condition. In a phylogenetic analysis of *Termitomyces*, Frøslev et al. (2003) found two named collections of *T. entolomoides* were molecularly very divergent: one (tgf10, from E. Turnbull & R. Watling) was molecularly close to *T. clypeatus* and the other (tgf103, from B. Buyck) to *T. microcarpus*. However, no description of these two collections is available and the present authors have been unable to obtain the material for comparison with the Chinese collection. The associated termite of *T. entolomoides* is *Macrotermes gilvus* (Hagen) in Malaysia (Pegler & Vanhaecke 1994).

Termitomyces eurrhizus (Berk.) R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 140 (1942).

≡ *Agaricus eurrhizus* Berk., Lond. Journ. Bot. 6: 483 (1847).
≡ *Armillaria eurrhiza* (Berk.) Sacc. [as "*eurhiza*"], Syll. Fung. 5: 85 (1887).
≡ *Collybia eurrhiza* (Berk.) Höhn. [as "*eurhiza*"], Sitzungsber. K. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 117: 992 (1908).
≡ *Rajapa eurrhiza* (Berk.) Singer [as "*eurhiza*"], Lloydia 8: 143 (1945).
= *Collybia albuminosa* sensu Petch, Ann. Roy. Bot. Gard., Peradeniya 5: 268 (1912), non *Agaricus albuminosus* Berk. (see Pegler 1994).
= *Termitomyces cartilagineus* (Berk.) R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 116 (1942) (see Pegler 1977).

= *Termitomyces poonensis* Sathe & S.D. Deshp., Maharashtra Assoc. Cult. Sci., Monograph 1: 36 (1981) ["1980"] (see Tang et al. 2006a).

= *Termitomyces quilonensis* Sathe & J.T. Daniel [as "*quilonesis*"], Maharashtra Assoc. Cult. Sci., Monograph 1: 103 (1981) ["1980"] (see Tang et al. 2006a).

= *Termitomyces albiceps* S.C. He, Acta Mycol. Sin. 4: 106 (1985) (see Tang et al. 2006b).

= *Termitomyces macrocarpus* Z.F. Zhang & X.Y. Ruan, Acta Mycol. Sin. 5: 10 (1986) (see Tang et al. 2006b).

= *Termitomyces albuminosus* sensu auct. Sin.

Pileus 7.0–20 cm diam., convex at first, applanate to concave when mature with round or bluntly pointed perforatorium; surface brown, reddish brown, dark brown to almost black at centre, white, pale yellow, pale grey, yellowish brown to dark brown elsewhere, usually paling toward margin, smooth and glabrous, rimose and striate radially; margin straight when mature, often splitting. Lamellae free, white to pinkish, 2.0–9.0 mm wide, crowded, with lamellulae. Stipe 3.0–15.0 × 0.5–2.8 cm, central, cylindrical and more or less thickening at ground level; surface white, and turning into pale yellowish brown close to ground level, smooth or with a few ephemeral remnants of partial veil; solid, fibrous, of longitudinally parallel hyphae, thin-walled and hyaline, 2.0–20 µm diam. Pseudorhiza 35 cm or more long, tapering; surface dark brown just under ground level, and black below, cartilaginous, striate and cracked longitudinally; solid, fibrous, of parallel to subparallel hyphae, thin-walled and hyaline, 2.5–35 µm diam. Partial veil present between pileus edge and stipe surface, fragile, absent when mature or occasionally forming small squamules on stipe surface. Context 2.0–10.0 mm thick, white, fleshy, of inflated hyphae, thin-walled and hyaline, 2.5–8.0 µm diam. in normal, and inflating to 35 µm. Basidiospore deposit pinkish. Basidiospores 6.0–9.0(–12.5) × 4.0–6.0(–7.5) µm, ovoid to ellipsoid; thin-walled, subhyaline. Basidia 15.0–29 × 5.0–9.0 µm, clavate, bearing four sterigmata; thin-walled, subhyaline. Lamella edge heterogeneous, crowded with numerous cheilocystidia and few basidia. Cheilocystidia 13.0–55 × 9.0–33 µm, clavate to pyriform; thin-walled, hyaline. Pleurocystidia 18.0–69 × 10.0–35 µm, clavate to pyriform, or fusiform occasionally; thin-walled, hyaline. Hymenophoral trama 50–90 µm wide, regular, of thin-walled and hyaline hyphae, 4.0–20 µm diam. Subhymenial layer 8.0–18.0 µm wide, of repent branched hyphae, 2.0–6.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae with yellowish pigment, 2.0–4.5 µm diam.

Specimens examined: CHINA. Yunnan: Kunming, purchased in local market, 21 Sept 1997, sin coll. 97-118 (HKAS 31891); ibid, Oct 2000, X.-H. Wang 1187 (HKAS 36868); ibid, purchased in local market, 24 Jul 2004, B.-H. Tang T0403 (HMAS 98972), B.-H. Tang T0404-1 (HMAS 98966), B.-H. Tang T0401 (HMAS 96673); Qiubei, 21 Jul 1977, M. Zang (HKAS 3461); Luquan, alt. 1900 m, on nest of *O. formosanus*, 9 Jul 1980, Z.-F. Zhang 5 (HKAS 9431); Xundian, Xiaodianwei Village, purchased from local villager, 26 Jul 2004, Y.-B. Wu T0408 (HMAS 98973), B.-H. Tang T0412 (HMAS 86667); Puer, 12 Sept 1986, K.-K. Chen 74 (N) (HKAS 18186); Mengla, Menglun Town, purchased in the

local market, 8 Aug 2004, M. Li T0490 (HMAS 86663); ibid, 5 Aug 2004, B.-H. Tang and A.-Y. Li T0484 (HMAS 96676); ibid, Menglun Town, Xishuangbanna Tropical Botanic Garden, 8 Aug 2003, G.-R. Hu and T.-Z. Wei W03-27 (HMAS 88326), G.-R. Hu and T.-Z. Wei W03-21 (HMAS 84723); ibid, 10 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 68 (HMAS 76622); ibid, 4 Aug 1988, Z.-L. Yang 262 (HKAS 21785); ibid, alt. 580 m,9 Aug 1988, Z.-L. Yang 342 (HKAS 21786); ibid, 2 Aug 2004, M. Li and B.-H. Tang T0457 (HMAS 98977), M. Li T0453 (HMAS 96507), A.-Y. Li and B.-H. Tang T0470 (HMAS 96516), A.-Y. Li and B.-H. Tang T04108 (HMAS 96677); ibid, 5 Aug 2004, B.-H. Tang and A.-Y. Li T0478 (HMAS 96509); ibid, 7 Aug 2004, M. Li and B.-H. Tang T0489 (HMAS 96496); Chuxiong, Nanhua, purchased in the local market, 17 Aug 2004, J.-Y. Chen, T04117 (HMAS 96510); Jinggu, Mengban, 21 Aug 1991, Z.-L. Yang 1620 (HKAS 23961); Jingdong, Phenix Mountains, alt. 1268 m, 25 Aug 1991, Z.-L. Yang 1641 (HKAS 23962), G. Song 291 (HKAS 23969); ibid, 29 Jul 1998, X.-H. Wang 488 (HKAS 32897); Simao, purchased in local market, 10 Aug 2003, T.-Z. Wei and Q.-B. Wang W03-30 (HMAS 85229); ibid, Xima River, alt. 1450 m, 2 Aug 1991, P.-G. Liu 810 (HKAS 24635); ibid, Caiyang River Nature Reserve, alt. 1680 m, 23 Jun 2000, M. Zang 13601 (HKAS 36001); ibid, alt. 1500 m, 16 Jul 2000, M. Zang 13334 (HKAS 36196); ibid, alt. 1680 m, 3 Jul 2000, M. Zang 13502 (HKAS 36497); Baoshan, Golden Cock Town, 21 Aug 1992, Z.-L. Yang (HKAS 25497); ibid, 30 Sept 1998, Z.-L. Yang 2571 (HKAS 32111); Yuxi, purchased in local market, 1 Jul 1998, X.-H. Wang 315 (HKAS 32969), X.-H. Wang 316 (HKAS 32972). Sichuan: Chengdu, purchased in local market, 30 Aug 2002, B. Wang 200252 (HMAS 84529); ibid, 12 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH326 (HMAS 79896); Huidong, Aug 1982, SCHC 82025 (HKAS 13269), SCHC 82017 (HKAS 13270); Pujiang, 5 Sept 1986, M.-S. Yuan 1301 (HKAS 18350); ibid, purchased in local market, 18 Aug 2002, B. Wang 200227 (HMAS 84518), B. Wang 200228 (HMAS 84516), B. Wang 200229 (HMAS 76898), B. Wang 200230 (HMAS 76909), B. Wang 200233 (HMAS 77064), B. Wang 200234 (HMAS 83595), B. Wang 200235 (HMAS 76913), B. Wang 200237 (HMAS 76899), B. Wang 200238 (HMAS 84517), B. Wang 200241 (HMAS 76895), B. Wang 200243 (HMAS 77060), B. Wang 200242 (HMAS 84530), B. Wang 200253 (HMAS 84527); ibid, 20 Aug 2002, B. Wang 200239 (HMAS 77063); Dechang, purchased in local market, 19 Jul 2002, B. Wang 20023 (HMAS 84526), B. Wang 20024 (HMAS 76912); ibid, 31 Jul 2002, B. Wang 200211 (HMAS 76902); ibid, Badong Town, 16 Aug 2003, T.-Z. Wei and L. Jiao W03-50 (HMAS 79891); ibid, 15 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-37 (HMAS 84715), H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-41 (HMAS 84722); ibid, 14 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-40 (HMAS 86686); ibid, 13 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH328 (HMAS 84726), H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH329 (HMAS 85226); ibid, 12 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao DH326 (HMAS 79897); Miyi, purchased in local market, 7 Aug 2002, B. Wang 200216 (HMAS 76908); Shuangliu, purchased in local market, 12 Aug 2002, B. Wang 200224 (HMAS 76903), B. Wang 200226 (HMAS 84521); Jianyang, purchased in local market, 30 Aug 2002, B. Wang 200246 (HMAS 76896), B. Wang 200247 (HMAS 76904), B. Wang 200248 (HMAS 84519), B. Wang 200249 (HMAS 84524), B. Wang 200250 (HMAS 76910), B. Wang 200251 (HMAS 77061). GUIZHOU: Xingyi, Baiwayao, alt. 1530 m, on nest of *O. formosanus*, 26 Aug 1983, S.-C. He 469 (HKAS 14660, paratype of *T. albiceps*); ibid, on nest of *O. formosanus*, 22 Aug 1983, S.-C. He 1056 (HMAS 47850, paratype of *T. albiceps*). XIZANG: Muotuo, 17 Jul 1983, Y.-G. Su 4850 (HKAS 15987), Y.-G. Su 4850B (HKAS 16184); ibid, on termite nest, 24 Jul 1983, X.-L. Mao 1139 (HMAS 50901); ibid, 11 Jul 1983, X.-L. Mao 1195 (HMAS 51474). Guangdong: Guangzhou, in mixed woodland, 30 May 1983, T.-H. Li (HMIGD 7184); ibid, Guangzhou Botanic Garden, 5

Jul 1985, G.-Y. Zheng (HMIGD 6569); Chaozhou, Phenix Mountains, alt. 400–450 m, solitarily grow on termite nest, 13 May 1986, G.-Y. Zheng (HMIGD 10437); ibid, 18 May 1986, G.-Y. Zheng (HMIGD 10491); Taishan, Shangchuan Island, 21 Jun 1987, Z.-S. Bi and T.-H. Li (HMIGD 11628); Yangchun, Guigang Town, alt. 600 m, on termite nest, 17 Jun 1987, Z.-S. Bi (HMIGD 11619). HAINAN: Ledong, Jianfeng Mountains, alt. 680–730 m, on termite nest in broad leaved forest, 17 Aug 1988, H.-Q. Chen (HMIGD 15478).

Termitomyces eurrhizus is one of the species in the genus typified by large basidiomata in the genus. Its pileus often exceeds 12 cm in diameter. The species can be recognized mainly by the cartilaginous blackish pseudorhiza (Heim 1942, Pegler 1977, 1986, Pegler & Vanhaecke 1994). The pileal surface of *T. eurrhizus* is diversified from almost white to dark brown with basidiospores up to 12.5 × 7.5 µm. Some collections of *T. eurrhizus* were misidentified as *T. fuliginosus* or *T. robustus* previously in the Chinese herbaria and re-determined here based on black pseudorhiza.

Pegler & Rayner (1969) reduced *T. cartilagineus* to a synonym of *T. eurrhizus* and that is confirmed by this study based on examination of a collection from South Africa (PREM 43147). There are two other new species reported from China, namely *T. albiceps* and *T. macrocarpus*, also having a dark pseudorhiza by which they have been related to *T. eurrhizus*, and subsequently Tang et al. (2006b) confirmed the two taxa as conspecific with *T. eurrhizus*. According to Tang et al. (2006a), two additional new species from India, *T. poonensis* and *T. quilonensis*, are further synonyms of *T. eurrhizus*.

Termitomyces eurrhizus is one of the most common species of the genus with the widest distribution (Heim 1977, Pegler 1977, Pegler & Vanhaecke 1994) and has been found in many localities in the south of China (Teng 1963, Bi et al. 1994, 1997, Yuan & Sun 1995, Mao 2000). The termites associated include *Ancistrotermes latinotus* (Holmgren), *Pseudacanthotermes spiniger* (Sjöstedt) and *Odontotermes* sp. in Zambia (Piearce 1987) and with *M. gilvus* and *O. badius* Haviland in the south and southeast of Asia (Pegler & Vanhaecke 1994). In China, the species was found on nests of *Odontotermes* spp. and *Macrotermes* spp. (He 1985, Mao 1993, Yuan & Sun 1995).

Termitomyces globulus R. Heim & Gooss.-Font., Bull. Jard. Bot. État. 21: 216 (1951).

Pileus 12.0–21 cm diam., subglobose to applanate, perforatorium absent; surface reddish brown at centre, elsewhere yellowish brown, and paler toward margin, smooth, glabrous, often with radial fine striae, and cracking radially on expansion or drying; margin usually incurved or decurved when mature, splitting radially. Lamellae free, white to pinkish, 3.0–6.0 cm wide, crowded, with lamellulae. Stipe 4.0–7.0 × 1.2–3.0 cm, cylindrical, slightly widen at ground level; surface white, smooth, glabrous; solid, fibrous, of parallel hyphae, thin-walled and hyaline, 2.0–18.0 µm diam. Partial veil not found.

Pseudorhiza up to 35 cm or more long, tapering and often twisting; surface reddish brown to tawny brown, with longitudinal striae; solid and fibrous, consisting of subparallel hyphae, thin-walled and hyaline, 2.5–30 µm diam. Context 5.0–10.0 mm thick at perforatorium, white, fleshy, consisting of thin-walled, inflated hyphae, 2.5–7.5 µm diam., inflating to 35 µm. Spore deposit pinkish. Basidiospores 6.0–9.0 × 4.0–6.0 µm, ovoid to ellipsoid, thin-walled, subhyaline. Basidia 17.5–29 × 6.0–9.0 µm, clavate, bearing four sterigmata; thin-walled, subhyaline. Hymenophoral trama regular, consisting of with thin-walled, hyaline hyphae, 4.0–20 µm diam. Subhymenial layer 15.0 µm wide, of repent and branched hyphae 2.0–5.0 µm diam. Lamella-edge heterogeneous. Cheilocystidia 20–51 × 16.0–24 µm, clavate to pyriform, thin-walled, hyaline. Pleurocystidia 35–71 × 17.0–28 µm, clavate to pyriform, occasionally septate at apex, thin-walled, hyaline. Pileipellis a repent epicutis of narrow, radial hyphae, 2.0–7.5 µm diam., containing yellowish brown vacuolar pigments.

Specimens examined: CHINA: Sichuan: Miyi, 7 Aug 2002, B. Wang 200217 (HMAS 77062), B. Wang 200218 (HMAS 84515), B. Wang 200219 (HMAS 76897), B. Wang 200220 (HMAS 76911). Yunnan: Kunming, purchased in local market, 14 Aug 2004, B.-H. Tang T04112 (HMAS 98965), B.-H. Tang T04115 (HMAS 99991); ibid, 27 Jul 2004, B.-H. Tang T0414-3 (HMAS 96497), B.-H. Tang T0416 (HMAS 98976).

Termitomyces globulus is characterized by its large basidioma, subglobose and non-umbonate pileus and dark pseudorhiza. The species is similar to *T. eurrhizus* and *T. robustus*, differing, however, by the lack of a perforatorium, which is conspicuous in the other two species. Furthermore, the pileus margin of *T. eurrhizus* and *T. robustus* are straight or even upwardly curved when mature, but *T. globulus* still remains decurved to incurved. Furthermore, *T. globulus* has a brown to reddish brown pseudorhiza, differing from the black one of *T. eurrhizus*.

Termitomyces globulus was reported in central Africa (Heim 1951, 1977, Otieno 1966, Pegler 1977, Turnbull & Watling 1999) and Southeast Asia (Pegler & Vanhaecke 1994), and Bels & Pataragetvit (1982) reported that the species symbioses with *Macrotermes* spp.

Termitomyces heimii Natarajan, Mycologia 71: 853 (1979).

≡ *Termitomyces albuminosus* sensu R. Heim, Termit. et Champ.: 100 (1977), non *Agaricus albuminosus* Berk.

= *Termitomyces longiradicatus* Sathe & J.T. Daniel [as "*longiradicata*"], Maharashtra Assoc. Cult. Sci., Monograph 1: 102 (1981) ["1980"] (see Tang et al. 2006a).

= *Sinotermitomyces cavus* M. Zang, Mycotaxon 13: 172 (1981) (see Wei et al. 2006).

Pileus 1.5–9.0 cm diam., subglobose to campanulate at first, convexo-applanate with round perforatorium when mature; surface pale grey to dark brown at centre, white to cream elsewhere, completely covered by a partial veil when young, with persistent pale brown velar squamules when mature, and

perforatorium surface rough and occasionally covered by a discoid remains of partial veil; margin incurved when young and then becoming straight, often striate and splitting radially. Lamellae free, up to 8.0 mm wide, white to cream; crowded, with lamellulae. Stipe 2.0–8.0 × 1.0–2.2 cm, central, close to conical above annulus, and cylindrical below; surface annulate, white above annulus, and cream below with pale brown velar squamules formed by remains of partial veil; solid to soft, fibrous, of longitudinally parallel hyphae, thin-walled and hyaline, usually 2.0–7.5 µm diam., few up to 18.0 µm. Pseudorhiza 29 cm or longer, cylindrical, slender, with a disk in contact with comb of termite; surface cream, leathery; hollow. Partial veil thin and tough, eventually forming a persistent double annulus and squamules on pileus and stipe surfaces; membranous, consisting of narrow hyphae, which are compactly parallel-arranged and perpendicular to surfaces of pileus and stipe, 1.5–3.0 µm diam. Context up to 10.0 mm thick, white, fleshy, of inflated thin-walled hyphae, hyaline, 3.5–8.0 µm. diam., inflating to 30 µm. Basidiospore deposit cream. Basidiospores 6.0–9.5 × 4.0–6.0 µm, ovoid to ellipsoid; thin-walled and subhyaline. Basidia 18.0–29 × 6.0–8.5 µm, clavate, bear four sterigmata; thin-walled, subhyaline. Lamella edge heterogeneous. Cheilocystidia 21–35 × 14.0–20 µm, clavate to pyriform; thin-walled and hyaline. Pleurocystidia 20–34 × 11.0–18.0 µm, similar to cheilocystidia, rare. Hymenophoral trama up to 100 µm wide, regular; of thin-walled and hyaline hyphae, 5.0–20 µm diam. Subhymenial layer about 10.0 µm wide, of narrow repent hyphae, thin-walled, 2.0–4.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, 2.0–4.5 µm diam.

Specimens examined: CHINA: Yunnan: Jinghong, purchased in local market, 3 Aug 2003, T.-Z. Wei and Q.-B. Wang W03-6 (HMAS 77076); Mengla, Menglun Town, purchased in local market, 5 Aug 2003, M. Li, T.-Z. Wei and Q.-B. Wang W03-8 (HMAS 77075); ibid, 12 Nov. 1989, Z.-L. Yang 984 (HKAS 22118); ibid, 16 Jul 1990, J.-G. Shuai 1 (HKAS 22668); ibid, 30 Jul 2004, B.-H. Tang T0422 (HMAS 98988); Luxi, Santai Mountains, alt. 1370 m, 1 Jul 1977, X.-J. Li 36 (HKAS 2866); Tengchong, alt. 2100, on nest of termite, 8 Aug 1980, X.-J. Li 11 (HKAS 6533, holotype of *S. cavus*); ibid, 17 Jul 1979, S.-X. Ma 1 (HKAS 4613), S.-X. Ma 2 (HKAS 4613); Ruili, 13 Aug 1980, X.-J. Li 22 (HKAS 6568); Longling, 2 Jul 1977, X.-J. Li 73 (HKAS 3664); Mangshi, 10 Aug 1980, M. Zang (HKAS 6545); Simao, on nest of termite, alt. 1500 m, 14 Jun 2000, M. Zang 13287 (HKAS 36153); ibid, alt. 1400 m, 17 Jun 2000, M. Zang 13372 (HKAS 36154); Jinggu, 10 Jul 1985, K.-Y. Guan 1 (HKAS 14626). XIZANG: Muotuo, 25 Sept 1983, Y.-G. Su 1343 (HKAS 16253).

Termitomyces heimii is a medium-sized species, and chiefly differs from other *Termitomyces* species by the velar squamules on the pileus and stipe surfaces, a double-ringed annulus and a hollow pseudorhiza. Wei et al. (2006) proved the type species of *Sinotermitomyces*, *S. cavus*, to be a synonym of *T. heimii*. Further, *T. longiradicatus*, a new species from Southwest India, is also conspecific with *T. heimii* (Tang et al., 2006a).

Termitomyces heimii was proposed by Natarajan (1979) based on of a collection from India which was misidentified as "*T. albuminosus* (Berk.) R. Heim" by Heim (1977). The species is widely distributed in south and south-east Asia (Natarajan 1979, Pegler & Vanhaecke 1994, Turnbull & Watling 1999), but it has not been found outside Asia. It was reported from Yunnan and Fujian, but was subsequently shown to be distributed only in South Yunnan and South-east Xizang in China (this study). *Termitomyces heimii* grows on the nests of a few *Odontotermes* species, including *O. grandiceps* in Malaysia (Pegler & Vanhaecke 1994) and *Odontotermes* spp. in China (Zang 1981b).

Termitomyces mammiformis R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 147 (1942).

= *Sinotermitomyces carnosus* M. Zang, Mycotaxon 13: 172 (1981) (see Wei et al. 2006).

= *Sinotermitomyces griseus* M. Zang, Mycotaxon 44: 22 (1992) (see Wei et al. 2006).

= *Sinotermitomyces rugosiceps* M. Zang, Mycotaxon 44: 23 (1992) (see Wei et al. 2006).

Pileus 3.5–8.5 cm cm in diam., at first subglobose or campanulate, and then becoming applanate with a mammiform, scrobiculate perforatorium; surface pale brown to dark brown at centre, and white to cream elsewhere, covered by a persistent cream partial veil when young, and attached by some firm pale grey to pale brown velar squamules when mature; margin incurved to straight, striate radially, and often splitting when mature. Lamellae free, 3.0–5.0 mm wide, surface white to pinkish, crowded, with lamellulae. Stipe 2.0–10.0 or more long, and 0.6–1.9 cm diam. at annulus, central, close to conical above annulus, and cylindrical below or occasionally slightly enlarged at ground level; surface white and glabrous above annulus, and cream-colored and with pale brown squamules below; solid, fibrous, of longitudinally parallel hyphae, thin-walled and hyaline, 2.0–7.0 µm diam. Pseudorhiza up to 40 cm long, cylindrical, with a basal disk connecting to the comb of symbiotic termite; surface cream, leathery; hollow. Partial veil covering whole surface of pileus and stipe at first, and breaking into firm squamules and forming persistent double annulus on the upper surface; composed of narrow hyphae which are compactly parallel-arranged and perpendicular to the surfaces of pileus and stipe, 2.0–3.0 µm diam. Context white, fresh; solid to soft, of inflated hyphae, thin-walled and hyaline, 2.0–8.0 µm diam., and inflating to 28 µm. Basidiospore deposit cream. Basidiospores 6.0–8.5 × 4.0–6.0 µm, ovoid to ellipsoid, subhyaline and thin-walled. Basidia 16.0–28 × 6.0–9.0 µm, subhyaline and thin-walled, clavate, bearing 4 sterigmata. Lamella edge heterogeneous. Cheilocystidia 16.0–43 × 9.0–25 µm, clavate to pyriform, hyaline and thin-walled. Pleurocystidia 15.0–36 × 9.0–20 µm, similar to cheilocystidia, rare. Hymenophoral trama regular, 50–100 µm wide, of hyaline, thin-walled tube-like hyphae, 4.0–20 µm diam. Subhymenial layer up to 12.0 µm wide, of branched and repent hyphae, 2.0–5.0

μm diam. Pileipellis a repent epicutis of narrow, radial hyphae, 3.0–5.0 μm diam.

Specimens examined: CHINA: Yunnan: Xishuanbanna, 12 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun (HMAS 76625); Mengla, 10 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 58 (HMAS 76553); Mengla, Menglun Town, purchased in local market, B.-H. Tang T0423 (HMAS 98987); Tengchong, on nest of termite, 30 Aug 1980, M. Zang (HKAS 6752, holotype of *S. carnosus*); Longchuan, 24 May 1992, M. Zang (HKAS 25361); Dehong, alt. 800 m, 9 May 1992, M. Zang 11907 (HKAS 25359); ibid, alt. 820 m, 19 May 1992, M. Zang 11908 (HKAS 25360); XIZANG: Muotuo, alt. 1250 m, on nest of termite, 3 Sept 1982, Y.-G. Su 1080 (HKAS 15983).

Termitomyces mammiformis is uniquely distinguished within the genus by a mammiform and scrobiculate perforatorium. The species may be closely allied to *T. heimii*, which differs by an obtusely rounded perforatorium. The perforatorium of *T. robustus* is also mammiform, but it lacks an annulate and scrobiculate stipe. Wei et al. (2006) investigated material of *S. carnosus*, *S. griseus* and *S. rugosiceps* and concluded all are synonymous with *T. mammiformis*. Further, Pegler (1977) observed the holotype collection of *T. rabuorii* Otieno, which also had a scrobiculate perforatorium, and considered it to be *T. mammiformis*. However, according to descriptions of Otieno (1966) and Pegler (1977), the pseudorhiza surface of *T. rabuorii* is dark brown and distinctly differs from that of *T. mammiformis*. Therefore, the identity of *T. rabuorii* requires further clarification.

Termitomyces mammiformis was published by Heim (1942) based upon material from the Republic of Guinea (formerly French Guinea). Similarly to *T. heimii*, *T. mammiformis* is only distributed in the South Yunnan and Southeast Xizang in China. The original record of a collection from Malaysia (KM 16528, cited by Pegler & Vanhaecke (1994)) shows that the species symbioses with *Odontotermes* spp.

Termitomyces microcarpus (Berk. & Broome) R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 128 (1942).

≡ *Agaricus microcarpus* Berk. & Broome, Journ. Linn. Soc., Bot. 11: 537 (1871).
≡ *Entoloma microcarpum* (Berk. & Broome) Sacc., Syll. Fung. 5: 687 (1887).
≡ *Mycena microcarpa* (Berk. & Broome) Pat., Bull. Soc. Mycol. Fr. 29: 210 (1913).
≡ *Gymnopus microcarpus* (Berk. & Broome) Overeem, in Heyne, Nutt. P. Ned.-Ind., ed. 2, 1: 76 (1927).
≡ *Podabrella microcarpa* (Berk. & Broome) Singer, Lloydia 8: 144 (1945).
= *Hiatula tonkinensis* Pat., J. Bot. (Morot) 5: 308 (1891) (see Yang 2000).
= *Termitomyces narobiensis* Otieno, Proc. E. Afr. Acad. 2: 110 (1966) ["1964"] (see Pegler 1977).
= *Termitomyces badius* Otieno, Sydowia 22: 161 (1969) ["1968"] (see Pegler 1977).
? = *Termitomyces indicus* Natarajan, Kavaka 3: 63 (1976 ["1975"]).

Pileus 1.0–3.2(–4.2) cm, at first conical becoming applanate when mature, with small and obtusely pointed perforatorium; surface white, pale grey, dark

grey or greyish brown at centre, white to pale grey elsewhere, paling toward margin, smooth and glabrous, radially striate; margin straight, often splitting when mature. Lamellae free, 2.0–5.0 mm wide; white at first, becoming pinkish when mature; crowded, with lamellulae. Stipe 1.5–6.0(–8.0) × 0.1–0.4(–0.6) cm, central, cylindrical, stipe base abrupt or forming a root-like terminal of 1.0–4.0 cm long under ground level, in contact with debris of comb brought to ground level, surface white, smooth and glabrous, longitudinally striate; solid and fibrous, of longitudinally parallel hyphae, thin-walled and hyaline, 2.5–7.5(–10.0) µm diam. Partial veil absent. Context narrow, white and fleshy, of inflated hyphae, thin-walled and hyaline, normal hyphae 3.0–8.0 µm diam., inflating to 30 µm. Basidiospore deposit pinkish. Basidiospores 5.5–8.0 × 3.5–5.5 µm, ovoid to ellipsoid; thin-walled and subhyaline. Basidia 16.0–26 × 6.0–9.0 µm, clavate, bearing four sterigmata; thin-walled, subhyaline. Lamella edge heterogeneous. Cheilocystidia 15.0–48 × 9.0–20 µm, clavate to pyriform; thin-walled and hyaline. Pleurocystidia 23–44 × 9.0–26 µm, similar to cheilocystidia, rare. Hymenophoral trama regular, 50–60 µm wide, of thin-walled and hyaline hyphae, 4.0–20 µm diam. Subhymenial layer up to 15.0 µm wide, of branched and repent hyphae, thin-walled, 2.0–5.0 µm diam. Pileipellis a repent epicutis of narrow, repent, radial hyphae, thin-walled, 2.0–5.0 µm diam.

Specimens examined. CHINA. Yunnan: Lianghe Pasture, 31 Jul 1977, X.-J. Li 304 (HKAS 3475); Tengchong, 8 Aug 1980, M. Zang (HKAS 6505), M. Zang (HKAS 6517); Mengla, 10 Aug 1999, S.-X. Sun, H.-A. Wen and X.-L. Mao 63 (HMAS 63358); ibid, 9 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 45 (HMAS 78413); ibid, Menglun Town, at roadside, alt. 580 m, 4 Aug 1988, Z.-L. Yang 266 (HKAS 21787); ibid, 2 Sept 1990, Z.-L. Yang 1248 (HKAS 23285); ibid, 15 Aug 1994, M. Zang 12310 (HKAS 28115); ibid, 5 Aug 2003, G.-M. Li, T.-Z. Wei and Q.-B. Wang W03-10 (HMAS 85224); ibid, 6 Aug 2003, M. Li, T.-Z. Wei, Q.-B. Wang and G.-M. Li W03-13 (HMAS 85230); ibid, Menglun Town, Xishuangbanna Tropical Botanical Garden, 1 Aug 2004, M. Li and B.-H. Tang T0451 (HMAS 96501), M. Li and B.-H. Tang T0452 (HMAS 96492); ibid, 2 Aug 2004, M. Li and B.-H. Tang T0459 (HMAS 86660); ibid, 5 Aug 2004, A.-Y. Li and B.-H. Tang T0474 (HMAS 96500), A.-Y. Li and B.-H. Tang T0476 (HMAS 96494), A.-Y. Li and B.-H. Tang T0477 (HMAS 86668); ibid, 10 Aug 2004, M. Li and B.-H. Tang T04106 (HMAS 96517); Xundian, Xiaodianwei Village, 26 Jul 2004, Y.-B. Wu and B.-H. Tang T0410 (HMAS 96488), Y.-B. Wu and B.-H. Tang T0409 (HMAS 96671); Qujing, 20 Aug 1990, Z.-L. Yang (HKAS 23956); Jingdong, alt. 1650 m, 21 Aug 1991, P.-G. Liu 992 (HKAS 23958); Jiangcheng, Niuluo River, alt. 1400 m, 7 Aug 1991, Z.-L. Yang 1443 (HKAS 23974); Simao, alt. 1400 m, 6 Aug 1994, M. Zang 12281 (HKAS 28138); Menghai, Nannuo Mountains, alt. 1500 m, 8 Aug 1994, M. Zang 12289 (HKAS 28142); ibid, alt. 1200 m, 8 Aug 1994, Doi, Y. 80 (HKAS 28286); ibid, 15 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 214 (HMAS 85450); Jinghong, alt. 900 m, 14 Aug 1997, M. Zang 12809 (HKAS 30671); Binchuan, Jizu Mountains, 5 Aug 1989, Y.-C. Zong and Y. Li 104 (HMAS 59795); ibid, 23 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 424 (HMAS 78417). Sichuan: Dechang, Badong Town, 16 Aug 2003, Q.-B. Wang and S.-Z. Fu W03-48 (HMAS 84727), T.-Z. Wei and L. Jiao W03-43 (HMAS 79718); ibid, 15 Aug 2003,

H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-35 (HMAS 84728); ibid, Nanshan Town, 15 Aug 2003, H. Deng, Y.-J. Yao, S.-Z. Fu and L. Jiao W03-42 (HMAS 85231); Miyi, alt. 2000 m, 27 Jul 1986, M.-S. Yuan 1176 (HKAS 18356); Tongjiang, Ahe Town, 21 Jul 1996, M.-S. Yuan 2260 (HKAS 30688); Pujiang, 18 Aug 2002, B. Wang 200240 (HMAS 83596). GUIZHOU: Yinjiang, Fanjing Mountains, alt. 1000 m, Aug 1983, X.-L. Wu 945 (HKAS 14307). HAINAN: Danxian, 28 May 1988, G.-Y. Zheng (HMIGD 14647); Qiongshan, alt. 150–200 m, in group, 2 Jun 1988, T.-H. Li (HMIGD 14094); Wanning, 22 May 1988, T.-H. Li (HMIGD 13880). FUJIAN: Sanming, 1984, H.-Z. Li 175 (HMAS 51771); Wuyi Mountains, 1 VI 1998, X.-L. Mao 9422 (HMAS 74808). TAIWAN: Mingtan, 23 Aug 1994, C.-M. Chen 830178 (HKAS 30319).

Termitomyces microcarpus is one of the smallest species of the genus and grows from the debris of the termite's comb, thus differing from other taxa of the genus (Batra & Batra 1967, Bels & Pataragetvit 1982, Collins 1982, Pegler & Vanhaecke 1994, Hudler 1998). According to previous reports, the pileus of *T. microcarpus* is usually 1.0–2.5 cm diam., occasionally up to 3.6 cm (Otieno 1966, Pegler & Rayner 1969, Natarajan 1976, Heim 1977, Pegler 1977, 1986, Pegler & Piearce 1980, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994, Turnbull & Watling 1999). The pileus of most collections cited here is 1.0–3.2 cm diam. with two exceptions (HMAS 84727 and 84728) from Sichuan Province, of which the pileus is up to 4.2 cm diam. and no termite nests were found below them.

Termitomyces microcarpus resembles other small *Termitomyces* species, such as *T. medius*, *T. radicatus* and *T. tylerianus*, but is distinguished by the absence of a pseudorhiza (Otieno 1969, Pegler & Rayner 1969, Natarajan 1976, Heim 1977, 1986, Pegler & Piearce 1980, Van der Westhuizen & Eicker, 1990, Pegler & Vanhaecke 1994, Turnbull & Watling 1999). Some basidiomata of *T. microcarpus* have root-like stipe bases which are easy to be mistaken for pseudorhizae, so differentiation of these small *Termitomyces* species mostly depends on original ecological records. Further, the species often grows in very large numbers.

Termitomyces microcarpus has a long list of synonyms. Singer (1945) divided the species from *Termitomyces* on the absence of a true pseudorhiza, making it the type species of *Podabrella*. However, *Podabrella* was rejected by Frøslev et al. (2003) on the basis of a sequence analysis of nrDNA-LSU and mtrDNA-SSU. Pegler (1977) included three African species, *T. badius*, *T. narobiensis* and *T. orientalis*, which also lack true pseudorhiza, with *T. microcarpus*, and later *T. indicus* was added by Pegler & Vanhaecke (1994). Yang (2000) examined type material of *Hiatula tonkinensis* from Vietnam and confirmed synonymy under *T. microcarpus*.

Termitomyces microcarpus is one of the most common species within the genus and is widely distributed in central and southern Africa (Otieno 1966, Heim 1977, Pegler 1977, Pegler & Piearce 1980, Piearce 1987, Van der Westhuizen & Eicker 1990) and South and Southeast Asia (Natarajan 1976,

Pegler 1986, Pegler & Vanhaecke 1994). The symbiotic associates include *Odontotermes badius*, *O. transvaalensis* (Sjöstedt) and *O. vulgaris* (Haviland) in Africa (Piearce 1987, Van der Westhuizen & Eicker 1990), and *O. malaccensis*, *O. redemanni* (Wasmann) and *Ancistrotermes* spp. in Asia (Pegler & Vanhaecke 1994). In China, *T. microcarpus* was found to the south of Yangtze River (Wei & Yao 2003) and symbiotic with *M. barneyi* (Lu et al. 2000).

Termitomyces striatus (Beeli) R. Heim, Arch. Mus. Hist. Nat. Paris, sér. 6, 18: 140 (1942).

≡ *Schulzeria striata* Beeli, Bull. Jard. Bot. État. 15: 29 (1938).

Pileus 4.2–8.0 cm diam., applanate with a small and bluntly pointed perforatorium (up to 4 mm high); surface pale greyish brown at centre, elsewhere white to pale grey, smooth, glabrous; margin straight, striate and splitting radially. Lamellae free, 3.0–5.0 mm wide, white to pinkish; crowded, with lamellulae. Stipe 4.5–10.0 × 0.3–0.6 cm, central, cylindrical; surface white, smooth and glabrous; solid, fibrous, of longitudinally parallel hyphae, thin-walled, hyaline, 2.0–20 µm diam. Pseudorhiza up to 28 cm long, cylindrical, terminating in contact with symbiotic termite comb; surface white, longitudinally striate; solid and fibrous, of parallel to subparallel hyphae, thin-walled and hyaline, 3.0–25 µm diam. Partial veil membranous, fragile, absent when mature. Context 3.0–5.0 mm thick under perforatorium, white, fleshy, of inflated hyphae, thin-walled and hyaline, normal hyphae 2.0–8.0 µm diam., inflating to 30 µm. Basidiospore deposit pinkish. Basidiospores 5.5–8.0 × 3.5–5.5 µm, ovoid to ellipsoid; thin-walled and hyaline. Basidia 17.0–28 × 6.0–8.5 µm, clavate, bearing four sterigmata; thin-walled and subhyaline. Lamella edge heterogeneous. Cheilocystidia 17.0–30 × 7.0–15 µm, clavate to pyriform; thin-walled and hyaline. Pleurocystidia 17.0–35 × 8.0–16.0 µm, similar to cheilocystidia, rare. Hymenophoral trama 60–80 µm, of thin-walled, hyaline hyphae, 4.0–20 µm diam. Subhymenial layer up to 10.0 µm wide, of repent hyphae, 2.0–5.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, thin-walled, 2.0–5.0 µm diam.

Specimens examined: CHINA: Yunnan: Mengla, Menglun Town, on termite subterranean nest at roadside, 6 Aug 2003, M. Li, T.-Z. Wei, Q.-B. Wang and G.-M. Li W03-12 (HMAS 79892); ibid, 9 Aug 1999, X.-L. Mao, H.-A. Wen and S.-X. Sun 40 (HMAS 63534); Xishuangbanna Tropical Botanic Garden, on termite nest, 8 Aug 2003, G.-R. Hu and T.-Z. Wei W03-26 (HMAS 88329); ibid, 3 Aug 2004, A.-Y. Li T0464 (HMAS 98979), B.-H. Tang and A.-Y. Li T0468 (HMAS 98981), A.-Y. Li and B.-H. Tang T0469 (HMAS 96675); ibid, 8 Aug 2004, M. Li and B.-H. Tang T0498 (HMAS 96489), M. Li and B.-H. Tang T04101 (HMAS 96490), M. Li and B.-H. Tang T04102 (HMAS 96498); Kunming, purchased in local market, 16 Aug 2004, B.-H. Tang T04116 (HMAS 98983).

Termitomyces striatus was made the type species of the genus by Heim (1942). The species is characterized by medium-sized basidiomata, small and pointed

perforatorium and white pseudorhiza (Heim 1942, 1977, Pegler 1977, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994, Turnbull & Watling 1999). The species is very similar to *T. aurantiacus* but lacks a brightly colored pileus and the pileus is usually white, cream or pale grey. *Termitomyces striatus* grows from the nests of *Ancistrotermes*, *Odontotermes* and *Pseudacanthotermes* in Africa and in south and south-east of Asia (Heim 1977, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994). In China, the species was reported to be symbiotic with *Macrotermes* spp. and *Pseudacanthotermes* spp. in Sichuan by Ying & Zang (1994) and Yuan & Sun (1995), but the distribution of this species in China is restricted to Yunnan according to this study.

Termitomyces tylerianus Otieno, Proc. E. Afr. Acad. 2: 116 (1966) ["1964"].

Pileus 1.0–2.0 cm diam., applanate with a small and sharply pointed perforatorium; surface brown at centre, pale yellow elsewhere, smooth and glabrous, finely striate radially; margin straight, splitting radially. Lamellae free, 1.0–2.0 mm wide, pinkish; crowded, with lamellulae. Stipe 3.0–4.0 × 0.2–0.3 cm, central, cylindrical; surface white, smooth and glabrous; solid and fibrous, of longitudinally parallel hyphae, thin-walled and hyaline, 3.0–20 µm diam. Pseudorhiza 5.0 cm long, very slender, in contact with symbiotic termite comb; surface white to greyish white; solid, firbous, of longitudinally subparallel hyphae, thin-walled and hyaline, 5.0–15.0 µm diam. Partial veil absent. Context narrow, white, fleshy, of inflated hyphae, thin-walled and hyaline, 3.0–5.0 µm diam. normally, and inflating to 35 µm. Basidiospore deposit pinkish. Basidiospores 5.0–7.0 × 3.5–4.5 µm, ovoid to ellipsoid; thin-walled, subhyaline. Basidia 15.0–25 × 5.5–8.0 µm, clavate, bearing four sterigmata; thin-walled and sybhyaline. Lamella edge damaged, cheilocystidia not found. Pleurocystidia not found. Hymenophoral trama regular, 80 µm wide, of thin-walled and hyaline hyphae, 5.0–18.0 µm diam. Subhymenial layer up to 10.0 µm wide, of branched and repent hyphae, 2.0–5.0 µm diam. Pileipellis a repent epicutis of narrow, radial hyphae, thin-walled, 3.0–5.0 µm diam.

Specimens examined: CHINA: Yunnan: Mengla, Menglun Town, Xishuangbana Tropical Botanic Garden, 23 Aug 1990, Z.-L. Yang 1146 (HKAS 23290). Guangdong: Qujiang, alt. 500 m, growing in group on termite nest in broad-leaved forest, 28 Jul 1985, T.-H. Li (HMIGD 8667).

Termitomyces tylerianus was described by Otieno (1966) on the basis of specimens from Kenya. The species is one of the small species of *Termitomyces* and differs from *T. microcarpus* by the presence of a pseudorhiza. Compared with other small *Termitomyces* species with pseudorhizae, such as *T. medius* and *T. radicatus*, the pseudorhiza of *T. tylerianus* is longer and thinner and, moreover, the basidiomata of *T. tylerianus* are more slender than that of *T. medius*. A lack of collection details would make identification of *T. tylerianus* difficult.

Discussion

Among the 26 taxa of *Termitomyces* and six taxa of *Sinotermitomyces* reported in China (see Table 1), 11 of them are confirmed by this study as described above, whilst nine of them, including *T. albiceps*, *T. badius*, *T. cylindricus*, *T. macrocarpus* and five names in *Sinotermitomyces*, are synonyms of other *Termitomyces* names and three, namely *T. fuliginosus*, *T. medius* and *T. robustus*, were based on misidentification of collections as revealed by observation of original specimens by the present authors. *Termitomyces letestui* and *T. schimperi* are excluded from Chinese records because of significant differences between their Chinese and original descriptions. *Termitomyces albuminosus*, synonym of *Leucocoprinus cepistipes* (Sowerby) Pat. (see Pegler, 1986), was misapplied to Chinese records. *Sinotermitomyces meipengianus* is excluded based on examination of the type material (HKAS 43208), which is not *Termitomyces*, but a species of another genus, possibly in a group close to *Xerula* Maire and *Oudemansiella* Speg. The distribution in China of the remaining five taxa, *T. mammiformis* f. *albus*, *T. radicatus*, *T. spiniformis*, *T. striatus* f. *griseus* and *T. striatus* f. *ochraceus*, are unconfirmed by the lack of supporting specimens.

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Guignardia aesculi on species of *Aesculus*: new records from Europe and Asia

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Abstract — New localities of *Guignardia aesculi* on leaves of seven *Aesculus* species (×*carnea*, *flava*, *hippocastanum*, ×*neglecta*, *parviflora*, *pavia*, *turbinata*) were recorded in Europe. The teleomorph was found on overwintered leaves of *A. hippocastanum* in Slovakia. The occurrence of the *Guignardia* leaf blotch on *A. hippocastanum* and *A. turbinata* was also confirmed for the first time in South Korea. The causal fungus *Guignardia aesculi* and its conidial anamorph *Phyllosticta sphaeropsoidea* and spermatial synanamorph *Leptodothiorella aesculicola* are described in detail and illustrated. Pathogenicity of the fungus was confirmed by inoculating horse chestnut leaves with conidia.

Key words — *Botryosphaeriaceae*, *Hippocastanaceae*, morphology

Introduction

Guignardia aesculi (*Botryosphaeriaceae*) is a common leaf pathogen of various *Aesculus* species. It can almost totally defoliate trees through premature leaf fall. This pathogen causes serious damage of leaves (macular necrosis without leaf spot abscission) on young trees in nurseries. The symptoms (brown blotches on the leaves) can be confused with damage caused by a leaf-mining moth, *Cameraria ohridella* Deschka & Dimić. It is currently causing major problems in much of Europe, causing premature leaf fall, which looks very unattractive. However, numerous pin-point black dots (pycnidia) in the necrotic tissue distinguish blotch from insect damage and scorch due to drought or salt. Recent

invasion of a powdery mildew, *Erysiphe flexuosa* (Peck) U. Braun & S. Takam., in Europe, has been thoroughly documented (Zimmermannová-Pastirčáková et al. 2002, Kiss et al. 2004, Bolay 2005, Põldmaa 2006, Stoykov and Denchev 2008).

Guignardia aesculi is distributed in North America and Eurasia. Most of the published records include only the anamorph and the spermatial state of the fungus, but the teleomorph has been recorded in USA (Peck 1887, Stewart 1916), Western Germany (Schneider 1961), and England (Hudson 1987). The distribution of the fungus in Asia as well as the teleomorph has been very poorly studied. There are no modern detailed descriptions of all the different states of *G. aesculi* available.

This contribution deals with morphology, pathology, host range, and geographical distribution of the causal agent of horse chestnut leaf blotch.

Material and methods

Collections and microscopic observations — Living leaves of *Aesculus* ×*carnea* Hayne, *A. flava* Sol., *A. hippocastanum* L., *A.* ×*neglecta* Lindl., *A. parviflora* Walter, *A. pavia* L. and *A. turbinata* Blume naturally infected with the anamorph of *Guignardia aesculi* were collected in 2000–08 in ten European countries (Austria, Belgium, Croatia, Czech Republic, Hungary, The Netherlands, Poland, Russia, Slovakia, Slovenia), USA, and South Korea. Regular collecting of overwintered leaves was conducted to find the teleomorph of the fungus. In castle park in Ivanka pri Dunaji, Slovakia, a number of *A. hippocastanum* trees naturally infected with *G. aesculi* were marked in the autumn of 2000. The fallen infected leaves of *A. hippocastanum* lying on the ground were collected every 14 days in March and April 2001. Sampling was repeated in March and April 2008 in four Slovak localities (Bratislava, Giraltovce, Leopoldov, Nitra).

All samples were examined by a stereo (SZ51, Olympus, Tokyo, Japan) and a compound microscope (BX51, Olympus, Tokyo, Japan). Slide preparations were stained with lactophenol blue solution (Merck, Darmstadt, Germany). The observed characters were compared to previously published descriptions and documented photographically along with symptoms of attack.

Herbarium specimens were deposited in the herbarium of Institute of Forest Ecology SAS, Nitra, Slovakia. Selected specimens were deposited in the mycological herbarium of Slovak National Museum, Bratislava, Slovakia (BRA) and at the U.S. National Fungus Collections, USA (BPI). Collections from Slovenia were deposited in the private herbarium of F. Celar.

Isolation and inoculation — The fungus was isolated from samples of infected leaves of *A. hippocastanum* collected in Kračúnovce, Slovakia, in July 2000. Leaf tissue pieces with lesions were surface sterilized with 0.5% NaOCl for 1 min. Small pieces of tissue were excised, transferred to Petri dishes containing malt extract agar (Merck, Darmstadt, Germany), and incubated at 23±2°C. Colonies growing from the tissue pieces were subcultured onto malt extract agar and rice agar after five days. Test cultures were incubated on plates for two weeks.

To confirm the fungus pathogenicity and fulfill Koch's postulates, 3-yr-old seedlings of *A. hippocastanum* were inoculated with a *Phyllosticta* isolate. Healthy leaves of ten seedlings growing in plant pots in greenhouse were sprayed with the conidial suspension of the *Phyllosticta* anamorph of 2×10^5 conidia/ml to runoff with a hand-held atomizer. The inoculated leaves were covered with test tubes and the opening of the tubes plugged with cotton for four days. Five non-inoculated seedlings were used as a control and maintained in the same conditions in another compartment in greenhouse.

Taxonomic description

Guignardia aesculi (Peck) V.B. Stewart, Phytopathology 6: 9, 1916

≡ *Laestadia aesculi* Peck, Ann. Rep. N.Y. St. Mus. Nat. Hist. 39: 51, 1887

≡ *Botryosphaeria aesculi* (Peck) M.E. Barr, Contr. Univ. Mich. Herb. 2: 561, 1972

Anamorph: *Phyllosticta sphaeropsoidea* Ellis & Everh., Bull. Torrey Bot. Club 10: 97, 1883

≡ *Phyllostictina sphaeropsoidea* (Ellis & Everh.) Petr., Sydowia 10: 265, 1957

?= *Phyllosticta paviae* Desm., Ann. Sci. Nat., Bot., sér. 3, 8: 32, 1847

Synanamorph: *Leptodothiorella aesculicola* (Sacc.) Sivan., Bitunic. Ascomyc.: 165, 1984

≡ *Phyllosticta aesculicola* Sacc., Michelia 1: 134, 1878

≡ *Asteromella aesculicola* (Sacc.) Petr., Sydowia 10: 266, 1957

= *Phyllosticta aesculi* Ellis & G. Martin, J. Mycol. 2: 130, 1886

Representative specimens examined — On leaves of *Aesculus ×carnea*, **AUSTRIA:** Tulln, 18 Oct 2001, leg. K. Pastirčáková (BRA CR9831); Vienna, city centre, 12 Sep 2002, leg. M. Pastirčák (BPI 871186); **CZECH REPUBLIC:** Prague, Mala Strana, 10 Sep 2002, leg. K. Pastirčáková; **HUNGARY:** Budapest, Orlay utca, Várkert Rakpart, 19 Aug 2006, leg. K. Pastirčáková; **SLOVAKIA:** Rimavská Sobota, city park, 24 Aug 2001, leg. K. Pastirčáková (BPI 871185); **SLOVENIA:** Ljubljana, Rožna dolina, near old Tobacco factory, Sep 2002, leg. F. Celar.

On leaves of *Aesculus flava*, **SLOVENIA:** Ljubljana, near National Institute of Biology, May 2008, leg. F. Celar.

On leaves of *Aesculus hippocastanum*, **AUSTRIA:** Tulln, 22 Sep 2001, leg. K. Pastirčáková (BRA CR9832); Tulln, near Institute for Agrobiotechnology, 18 Oct 2001, leg. M. Pastirčák (BPI 871183); **BELGIUM:** Plankendaal, 10 Aug 2001, leg. M. Lemmens; **CROATIA:** Zagreb, Cmrok, park, 20 Sep 2001, leg. D. Diminić; **CZECH REPUBLIC:** Prague, city centre, 10 Sep 2002, leg. K. Pastirčáková (BPI 871181); **HUNGARY:** Budapest, Döbrentei tér, Várkert Rakpart, 19 Aug 2006, leg. K. Pastirčáková; **THE NETHERLANDS:** Wageningen, 10 Oct 2001, leg. A.M. de Haas; **POLAND:** Lublin, park, 9 Nov 2000, leg. K. Pastirčáková; **RUSSIA:** Saint-Petersburg, Ploschad Chenyshevskogo, 22 Sep 2007, leg. K. Pastirčáková; **SLOVAKIA:** Kračúnovce, school park, 28 Jul 2000, leg. K. Pastirčáková (BRA CR9833); Ivanka pri Dunaji, castle park, 21 Sep 2000, leg. K. Pastirčáková; Giraltovce, city park, 20 Aug 2001, leg. K. Pastirčáková (BPI 871184); Bratislava, Rusovce, park, Mar–Apr 2008, leg. M. Pastirčák; Giraltovce, city park, Mar–Apr 2008, leg. M. Pastirčák; Leopoldov, city, Mar–Apr 2008, leg. M. Pastirčák; Nitra, Nábrežie mládeže, Mar–Apr 2008, leg. K. Pastirčáková; **SLOVENIA:** Ljubljana, Rožna dolina, near old Tobacco factory, Sep 2002, leg. F. Celar; **SOUTH KOREA:** National Arboretum, 30 Sep 2005, leg. K. Pastirčáková; **USA:** Grove City, Pennsylvania, 14 Oct 2000, leg. P.M. Glova.

On leaves of *Aesculus ×neglecta*, **SLOVENIA:** Arboretum Volčji Potok, Sep 2006, leg. F. Celar.

On leaves of *Aesculus parviflora*, **AUSTRIA:** Vienna, city park, 26 Oct 2001, leg. K. Pastirčáková; **SLOVAKIA:** Arboretum Mlyňany, 21 Jul 2001, leg. K. Pastirčáková; **SLOVENIA:** Ljubljana, Botanical Garden, Sep 2006, leg. F. Celar.

On leaves of *Aesculus pavia*, **SLOVENIA:** Ljubljana, near National Institute of Biology, May 2008, leg. F. Celar.

On leaves of *Aesculus turbinata*, **SLOVENIA:** Ljubljana, near Biotechnical faculty, Aug 2007, leg. F. Celar; **SOUTH KOREA:** Forest Practice Research Center KFRI, 30 Sep 2005, leg. K. Pastirčáková; Seoul, Gwanghwamun, 5 Oct 2005, leg. K. Pastirčáková.

Symptoms — The first symptoms of leaf blotch disease, water-soaked irregular areas on living leaves, appear in May. Within a few days these turn reddish to brown, obtain a yellow border and coalesce. The lesions are variable in size and shape, often concrescent and cover extensive areas of the leaf. Minute black specks are seen scattered over the lesion (Figure 1A). Large lesions cause curling and distortion of leaflets. Small reddish brown elongate spots on petioles are also present.

Microscopic features — Teleomorph (based on Slovak material): Pseudothecia on dead leaves in spring, subepidermal, globose to subglobose (Figure 2A), solitary, dark brown, wall of textura angularis with thick-walled cells of outer layers (Figure 2B), ostiolate, 90–180 µm in diameter, containing 20–26 asci. Asci bitunicate, clavate to cylindrical, stalked, thickened and rounded at the apex, 8-spored, 55–80 × 16–28 µm (Figures 2C–2F). Ascospores one-celled, hyaline, straight or slightly curved, ovoid, ellipsoidal or rhomboidal, with a granular content, rarely guttulate, usually wider in the middle, 14–18 × 7–9 µm (Figures 2G–2I). Young ascospores possess mucilaginous cap-shaped appendages at one or both ends, which disappear at maturity. Pseudoparaphyses absent in mature pseudothecia.

Anamorph: Pycnidia on leaf spots in living leaves in summer and autumn, on both surfaces of lesions, but much more on the upper surface, epiphyllous, single, globose to pyriform, dark brown, immersed, 80–160 µm in diameter, unilocular, ostiolate, wall of textura angularis (Figures 1B, 3A). Subcircular ostiole 10–18 µm in diameter, surrounded by conspicuous dark brown cells. Conidiogenous cells holoblastic, cylindrical or conical, hyaline. Conidia hyaline, coarsely granular, rarely guttulate, smooth, thin-walled, one-celled, globose, ellipsoidal, clavate or obpyriform, 9–18 × 6–12 µm, surrounded by a thin mucilaginous sheath, with a hyaline apical appendage, 6–8(–12) µm long (Figures 3B–3F). Conidia held together by the gelatinous substance seen extruding from the ostiole as a white coil.

Synanamorph: Spermogonia similar in morphology to pycnidia, immersed, globose, dark brown, 40–95 µm in diameter. Spermatiogenous cells holoblastic, filamentous to cylindrical, long and slender. Spermatia one-celled, oblong cylindrical to dumb-bell shaped, hyaline, guttulate, straight or slightly curved, 3–10 × 0.5–2.5 µm (Figure 3G).

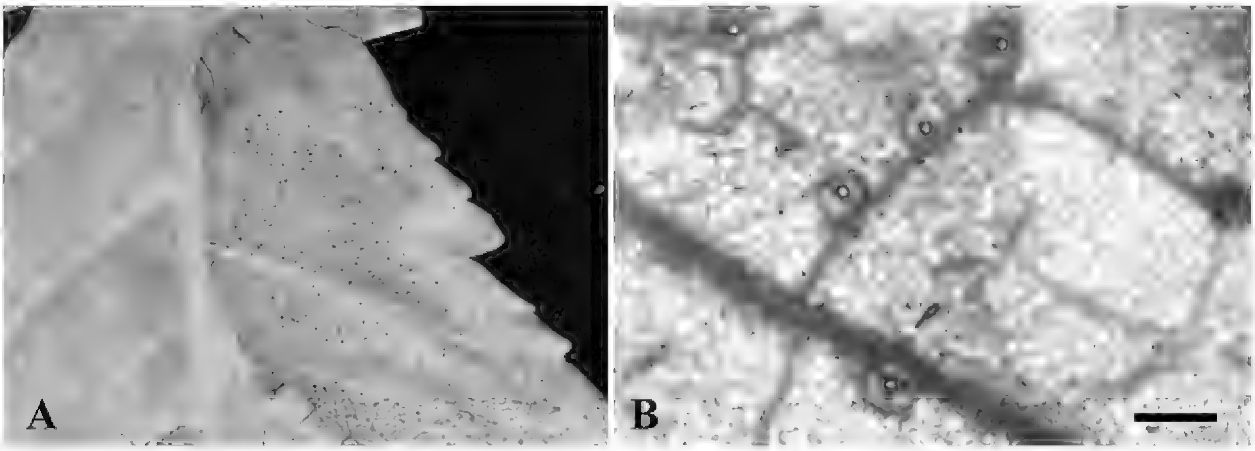

FIGURE 1. *Guignardia* leaf blotch. (A) a blotch with numerous pycnidia on naturally infected leaf of *Aesculus hippocastanum*; (B) pycnidia of the *Phyllosticta* anamorph in the necrotic tissue as viewed with a hand lens. Scale bar = 200 µm.

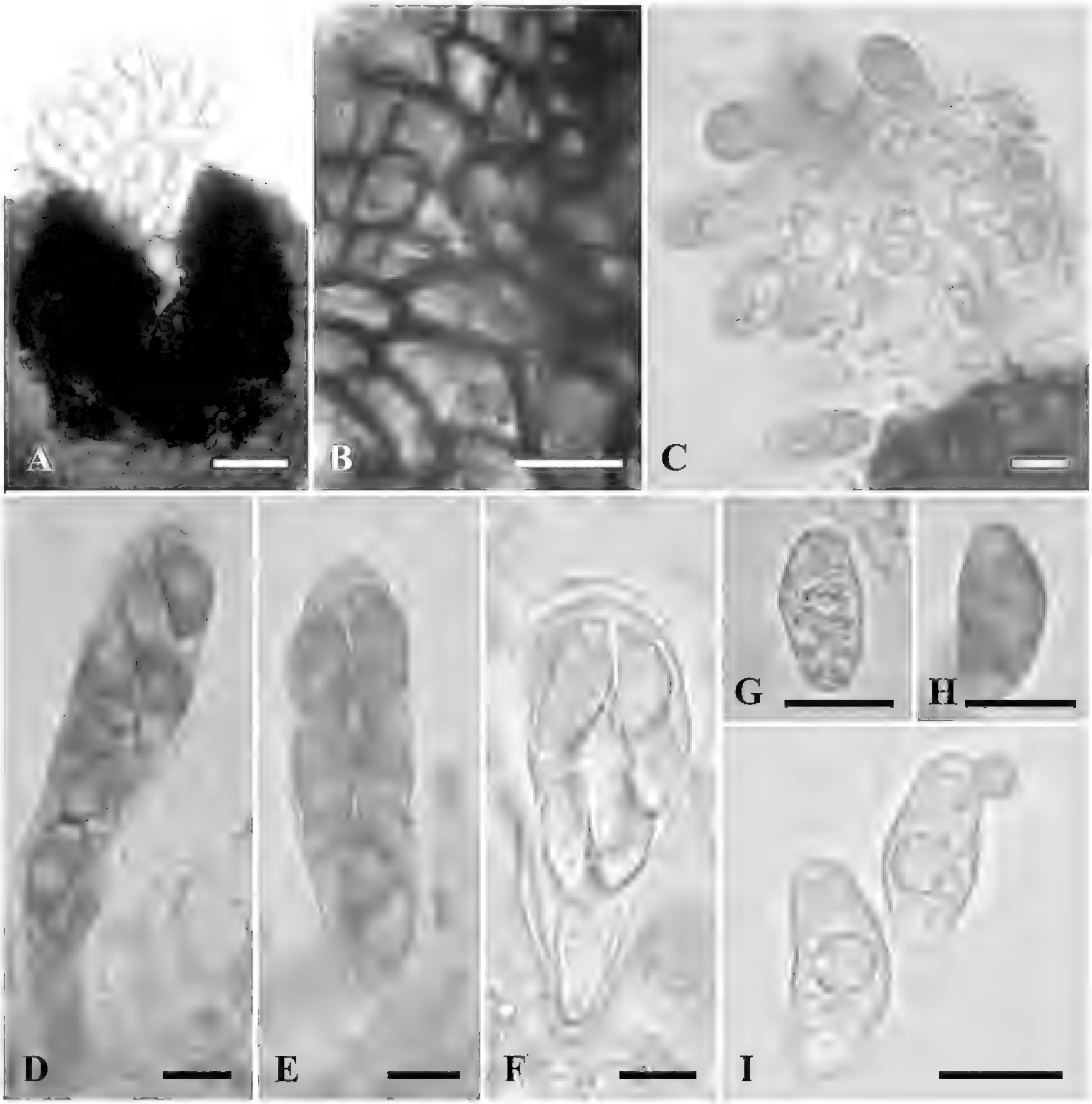

FIGURE 2. *Guignardia aesculi*. (A) pseudothecium with asci; (B) wall of pseudothecium of textura angularis with thick-walled cells of outer layers; (C) a cluster of mature asci; (D–F) bitunicate asci and ascospores; (G–I) ascospores. Scale bars = 40 µm (A), 20 µm (B), 30 µm (C), 10 µm (D–I).

Colonies: Isolates produced different colonies on malt extract agar and rice agar (Figure 4). Colonies grew slowly, on malt extract agar: aerial mycelium woolly, white, hyphae branched, septate, hyaline, 4–6 µm in wide (Figure 3H), dark pycnidia clustered, aggregated; on rice agar: aerial mycelium scanty, pycnidia abundant, dark, globose, solitary, rarely clustered, with conidial and spermatial cavities; ascomata not produced in culture. Cultural characters and the effect of different nutrient media, their pH value and the ultraviolet radiation on mycelial growth and sporulation in isolates of *P. sphaeropsoidea* have been described in an earlier paper (Zimmermannová-Pastirčáková 2003).

The fungus was identified as *Guignardia aesculi* on the basis of the characteristics described above. The morphological features of the teleomorph, anamorph and spermatial state observed in the collections from seven species of *Aesculus* (*A.* ×*carnea* [*hippocastanum* × *pavia*], *A. flava*, *A. hippocastanum*, *A.* ×*neglecta* [*flava* × *sylvatica*], *A. parviflora*, *A. pavia* and *A. turbinata*) correspond to those reported in previous publications (Stewart 1916, Sivanesan 1984, Punithalingam 1993).

The pycnidial anamorph was found in all examined samples. The spermatial state was found in most of the specimens, except for those of *A. hippocastanum* collected in Croatia and Czech Republic. Spermatia can be found in the same pycnidium together with *Phyllosticta* conidia (Treigiene 2006). A spermogonium has frequently been reported to develop immediately next to and in the same stroma with pycnidium, the two being separated only by a thin membranous wall (Stewart 1916).

The teleomorph was recorded on *A. hippocastanum* in Slovakia. The sexual fruiting bodies of the examined fungus were not present from June to November when the leaves were collected. The fungus forms pseudothecia in the old lesions during the winter and mature in the spring when new leaves are developing. Overwintering and formation of teleomorph of the fungus was repeatedly observed on naturally infected leaves of *A. hippocastanum* in 2001 and 2008 in four localities in Slovakia. The mature pseudothecia with asci and differentiated ascospores were observed in Slovak specimens collected in April 2001. In 2008 numerous mature pseudothecia were seen in lesions of specimens collected as early as 30th March. The description of the teleomorph based on these collections is given above.

Pathogenicity — Typical symptoms of leaf blotch began to develop approximately 10 days after the inoculation of *A. hippocastanum* seedlings with conidia. The symptoms of leaves artificially inoculated were identical to those of naturally infected leaves in the field. Further, pycnidia with conidia appeared in the lesions after 7 days. Control plants remained healthy. The pathogenicity test revealed that the isolate of *Phyllosticta sphaeropsoidea* from leaves of *A. hippocastanum* from Slovakia was pathogenic and when re-isolated from

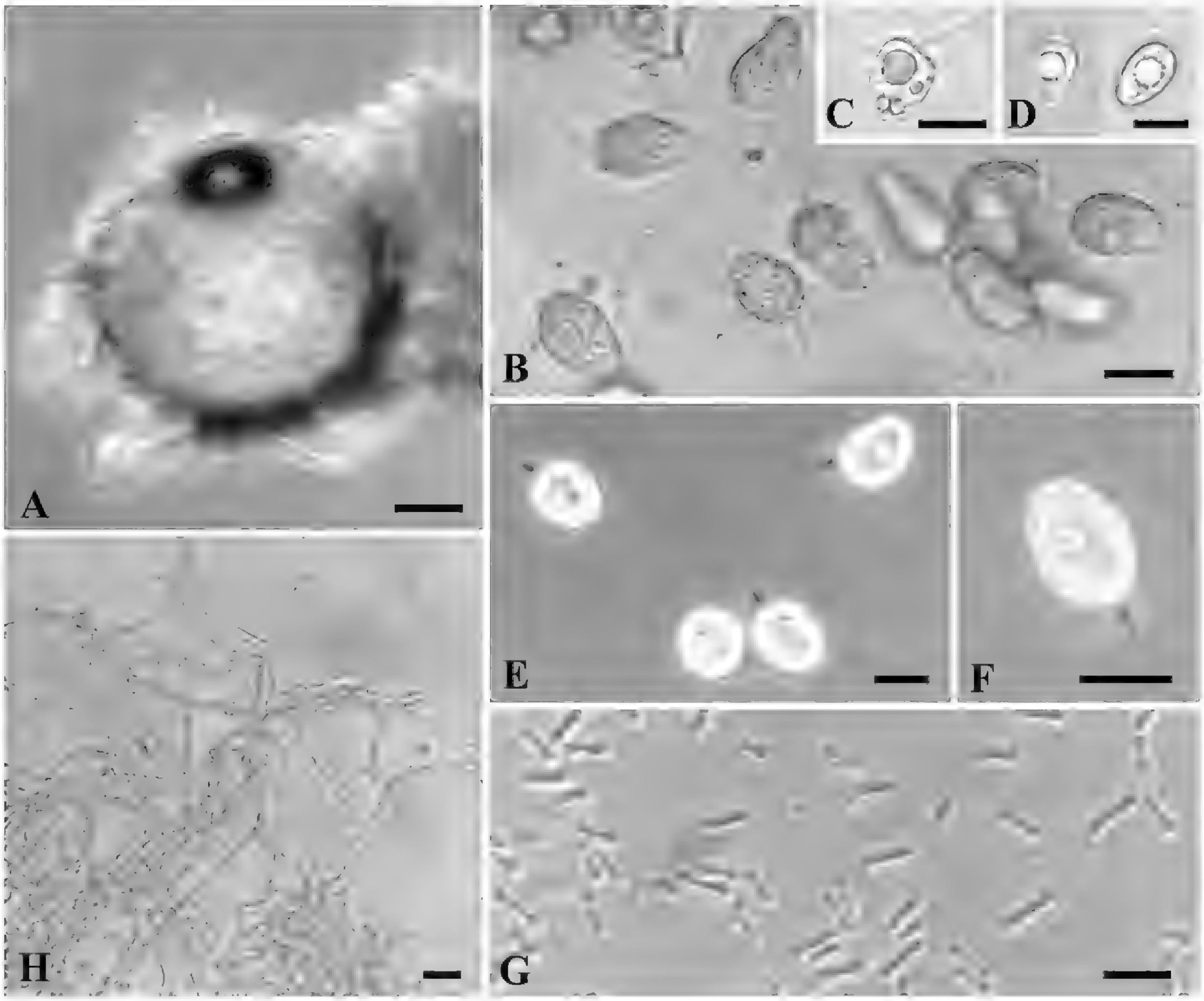

FIGURE 3. The anamorphs of *Guignardia aesculi*. (A–F) *Phyllosticta* anamorph: (A) pycnidium; (B, E, F) conidia with a granular content and (C, D) conidia with guttulae and apical appendages. (G, H) *Leptodothiorella* synanamorph: (G) spermatia; (H) hyphae of anamorphic state in culture. Scale bars = 30 µm (A), 10 µm (B–G), 20 µm (H).

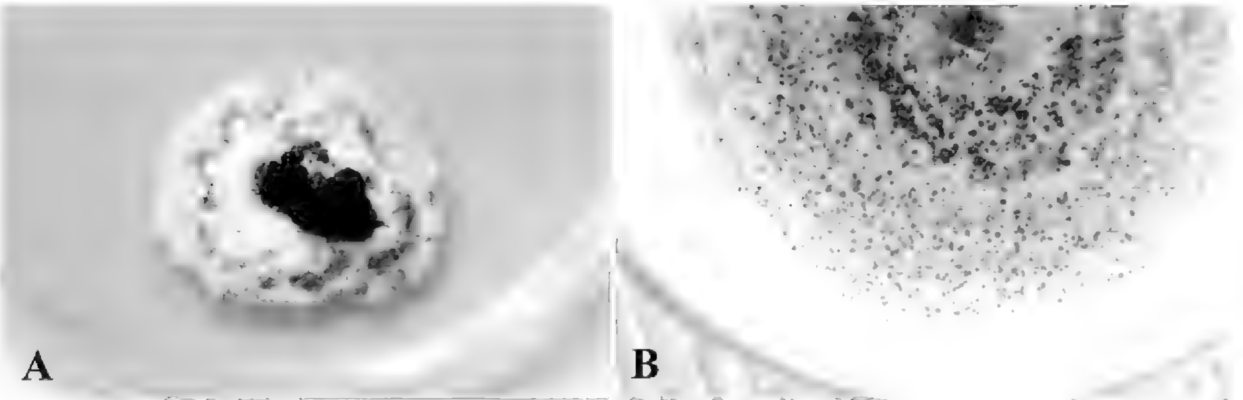

FIGURE 4. Cultures of *Phyllosticta* anamorph of *Guignardia aesculi*, 14-d old, inoculated from leaves of *Aesculus hippocastanum*. (A) on malt extract agar, (B) on rice agar.

successfully infected leaves, the fungus was identical to the initial isolate. Only *A. hippocastanum* seedlings were used for pathogenicity test because seedlings of other species could not be obtained.

Hudson (1987) reported characteristic lesions on horse chestnut leaves 4–6 weeks after inoculation with separate suspensions of conidia and ascospores.

TABLE 1. Global distribution of *Aesculus* species attacked by *Guignardia aesculi*

Geographic region		*Aesculus* spp.	References
North America	Canada	*glabra*, *hippocastanum*	Bissett & Darbyshire 1984
	USA	×*ambigua*, *arguta*, ×*arnoldiana*, ×*bushii*, *californica*, ×*carnea*, *chinensis*, *discolor*, *flava*, *georgiana*, *glabra*, ×*glaucescens*, *hippocastanum*, ×*hybrida*, ×*mutabilis*, ×*neglecta*, *parviflora*, *pavia*, *splendens*, *turbinata*, ×*woerlitzensis*	Neely & Himelick 1963, Neely 1971, Farr et al. n.d.
Europe	Austria	×*carnea*, *hippocastanum*, *parviflora*	Petrak 1957, this paper
	Bulgaria, Croatia, Estonia, Italy, Lithuania, Norway, Poland, Romania, Russia, Ukraine	*hippocastanum*	Scaramuzzi 1954, Milatović 1956, van der Aa 1973, Fakirova 1993, Andrianova 2006, Põldmaa 2006, Talgø et al. 2006, Treigiene 2006, this paper
	Belgium, England	*hippocastanum*, *indica*, *parviflora*	Grove 1935, Hudson 1987, Farr et al. n.d.
	Czech Republic, Hungary, Portugal, Switzerland	×*carnea*, *hippocastanum*	Scaramuzzi 1954, Caetano 1985, Bolay 2000, Magyar & Tóth 2003, this paper
	France	×*carnea*, *hippocastanum*, *indica*, *parviflora*	Vegh & Le Berre 1991, Farr et al. n.d.
	Germany	*glabra*, *hippocastanum*	Schneider 1961, Farr et al. n.d.
	Netherlands	*californica*, ×*carnea*, *hippocastanum*, *indica*, ×*mutabilis*, ×*neglecta*, *pavia*, *sylvatica*, ×*woerlitzensis*	de Haas pers. comm. 2001
	Slovakia	×*carnea*, *hippocastanum*, *parviflora*, *pavia*	Hrubík 1976, Juhásová et al. 1998, Farr et al. n.d., this paper
	Slovenia	×*carnea*, *flava*, *hippocastanum*, ×*neglecta*, *parviflora*, *pavia*, *turbinata*	Milatović 1956, this paper
Asia	Armenia	*hippocastanum*	Simonyan 1981
	China	*pavia*	Chen et al. 2007
	South Korea	*hippocastanum*, *turbinata*	This paper

Stewart (1916) carried out successful cross inoculations of *A. glabra* Willd. and *A. hippocastanum* seedlings by ascospores, with incubation period from 10 to 20 days, whereas inoculations of *A. parviflora* leaves with ascospores from *A. hippocastanum* failed. According to van der Aa (1973), inoculation experiments with conidia and ascospores of species of *Guignardia* have mostly shown that these are specific plant pathogens capable of infecting one host species or species of one host genus.

HOST RANGE AND DISTRIBUTION — The host range of *G. aesculi* is restricted to representatives from family *Hippocastanaceae*. Records of *Phyllosticta paviae* on

Thuja occidentalis L. and *Hamamelis* sp. in USA (Farr et al. n.d.) are probably assignable to *P. thujae* Bissett & M.E. Palm and *P. hamamelidis* Cooke ex G. Martin, respectively. Table 1 provides a list of all species and hybrids of the genus *Aesculus* attacked by *G. aesculi* reported in North American, European and Asian countries based on data in the literature. There are no herbarium collections of this fungus on the Asiatic species *A. assamica* Griff. and *A. parryi* A. Gray and the Mexican species *A. wilsonii* Rehder deposited in mycological herbaria listed in the Index Herbariorum database, and no records on these hosts in the literature.

For the first time we recorded *Guignardia* leaf blotch on *A.* ×*carnea* in Austria, Czech Republic and Hungary; on *A. hippocastanum* in Russia; and on *A. parviflora* in Austria and Slovakia. Six *Aesculus* species (*A.* ×*carnea*, *A. flava*, *A.* ×*neglecta*, *A. parviflora*, *A. pavia*, *A. turbinata*) are reported as new hosts for *G. aesculi* in Slovenia. The specimens from South Korea represent the first record of the species in the country and the third known locality from Asia.

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A lyophylloid *Entoloma* species (*Basidiomycota, Entolomataceae*) from Italy

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Abstract—An interesting species of *Entoloma* with a habit reminiscent of *Lyophyllum decastes* is described as new from a coastal dunes grassland in Sardinia, Italy. A comparison is made with similar species in- and outside Europe.

Riassunto— Viene descritta un'interessante nuova specie di *Entoloma* con un aspetto simile a quello di *Lyophyllum decastes*, raccolta in un prato di una duna costiera in Sardegna, Italia.

Key words—new species, agarics, *Agaricales*, *Entoloma decastes*

Introduction

The genus *Entoloma* has been studied by the third author on a world-wide scale (Gates & Noordeloos 2007, Manimohan et al. 2006, Noordeloos 1980, 1981, 1987, 1992, 2004, 2008; Noordeloos & Hausknecht 2007). Although the *Entoloma* flora is well explored in Europe, many species can still be discovered, particularly in the Mediterranean region (e.g., Noordeloos & Polemis 2008, Vila & Caballero 2007). The current paper deals with a remarkable species from the Island of Sardegna, Italy, mimicking a *Lyophyllum* species.

Taxonomy

Entoloma decastes Contu, Consiglio & Noordel., **sp. nov.** Fig. 1

MycoBank MB 513046

Pileus 10–50 mm latus, parum carnosus, convexus deinde expansus, demum centro depressus, plerumque parvo obtuso vel acuto umbone praeditus, glaber, radialiter

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fibrillosus sed laevis, sericeus, jove udo omnino pellucide striatus, atrobrunneus disco nigro in iuventute, deinde clarior, brunneolus, margine saepe pallidiore. Lamellae angustae in iuventute deinde satis crassae, mediocriter confertae vel confertae, sinuato-adnatae, uncinato-adnatae usque ad subdecurrentes, in iuventute griseo-brunneolae, acie pallidiore integra vel leviter serrulata. Stipes 10–30 mm longus, 2–3 mm crassus, plerumque brevior quam pilei diametron, demum cavus, cylindraceus basi aequali vel leviter inflate, in iuventute spissa pruina alba omnino obtectus deinde sine pruina, fibrillis longitudinalibus concoloribus vel clarioribus exornatus; mycelio albo. Caro fragillima, aquosa, pilei nigricula, stipitis aquose griseola, immutabilis. Odor laevis, farinosus; sapor farinosus. Sporae in cumulo roseae.

Holotypus: *Sardinia, Olbia-Tempio, Aglientu, locality Montirussu, in a sandy grassland on acid soil, 23.11.2007, leg. G. Consiglio, M. Contu, L. Setti & L. Perrone (L).*

Etymology.— named after its resemblance to *Lyophyllum decastes*.

Description—Pileus 10–50 mm, thin-fleshed, convex, expanding to applanate with slightly depressed centre, hygrophanous, distinctly translucently striate at margin, dark brown with blackish centre, glabrous, shiny, sericeus, radially fibrillose but not squamulose. Lamellae crowded, sinuate-adnate or subdecurrent, thickish, broad, greyish at first then pinkish brown. Stipe 10–30 × 2–3 mm, short, cylindrical, brownish grey whitish at base, apex pruinose, downward fibrillose. Context thin, greyish, black in pileus, grey in stipe. Smell and taste farinaceous.

Spores 11–14 × 9–12 µm, Q = 1.2–1.35–1.45, 6–8 angled in side-view. Basidia 24–33 × 7–11 µm, 4-spored, clamped. Lamellar edge fertile. Hymenophoral trama regular, made up of inflated elements, 60–120 × 11–30 µm. Pileipellis a differentiated cutis, suprapellis made up of cylindrical, 2–9 µm wide hyphae, subpellis made up of inflated elements, 20–70 × 8–20 µm, gradually passing into trama. Pileitrama regular, made up of inflated elements, 70–130 × 5–30 µm. Pigment abundant, very dark brown intracellular-granular and also coarsely incrusting in pileipellis and upper pileitrama. Clamp-connections abundant.

Habitat: in dense clusters of many specimens, in coastal grassland on sandy soil.

Collections examined: Italy: Sardinia, Olbia-Tempio, Aglientu, locality Montirussu, in a sandy grassland on acid soil, 26.12.2005, 2.01.2006, leg. M. Contu, Herbarium MC.; ibidem, 23.11.2007, leg. G. Consiglio, M. Contu, L. Setti & L. Perrone, (L, **holotype;** Herbarium *G.Consiglio,* n. 07454, isotype).

Entoloma decastes is a remarkable species with a growth-form reminiscent of a miniature *Lyophyllum decastes* (Fr.) Singer. The dark colored basidiocarps, prominent, double pigmentation in the pileipellis and particularly the large spores are distinctive. Taxonomically, it belongs to subgenus *Rhodopolia*. *Entoloma difforme* Naveau, another lyophylloid species with a clustered growth form, clearly differs by having smaller spores and lack of incrusting pigment (Noordeloos 2004). *Entoloma myrmecophilum* var. *coalescens* Noordel. &

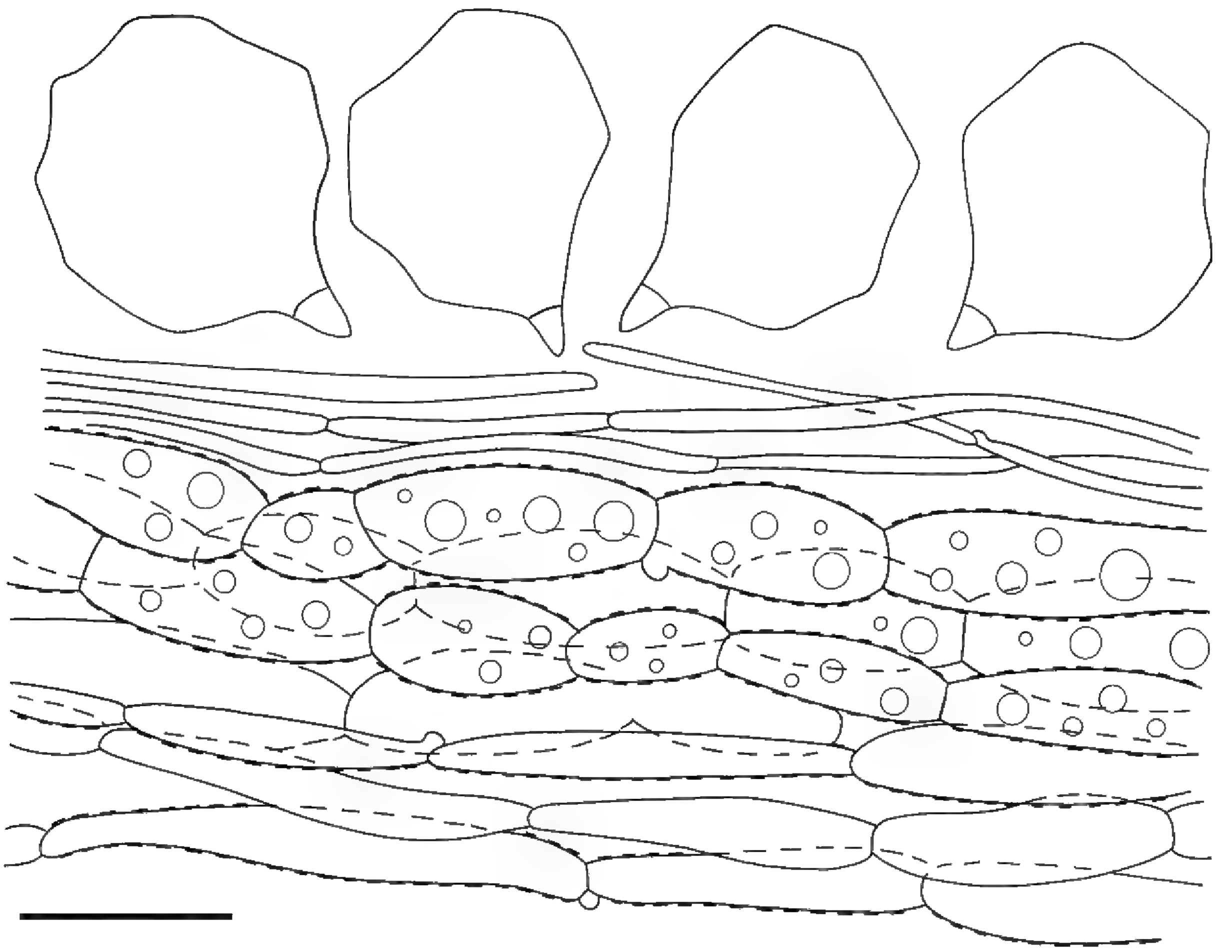

Fig. 1. *Entoloma decastes*. Holotype: spores and pileipellis. Bar = 10 µm.

Luhmann has a different stature, paler, not so distinctly translucently striate pileus, white stipe, and smaller spores. Some other dark colored species from the *Rhodopolia*, such as *E. gerriae* Noordel., *Entoloma griseopruinatum* Noordel. & Cheype have an opaque, not translucent, felted or pruinose pileus surface, and the latter also lacks incrusting pigment. *Entoloma fasciculatum* Hesler has a similar growth form, but differs by smaller spores and lack of incrusting pigment (Noordeloos 1988). Interestingly, no similar species have been encountered in temperate regions of Tasmania (Gates & Noordeloos 2007).

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Boreoplaca ultrafrigida (*Umbilicariales*), the correct name for *Rhizoplacopsis weichingii*

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Abstract — The type of *Boreoplaca ultrafrigida* is shown to be identical with *Rhizoplacopsis weichingii.* Consequently, the latter name is reduced to synonymy with *B. ultrafrigida*, and *Rhizoplacopsis* is reduced to synonymy with *Boreoplaca*. Systematical position of the genus is discussed on the basis of literature sources. The known distribution of *B. ultrafrigida* in Russia and China is summarized.

Key words — lichen, new synonym, *Ophioparmaceae, Rhizoplacopsidaceae*, biogeography, Asia

A new genus and species *Rhizoplacopsis weichingii*, the only representatives of a new family *Rhizoplacopsidaceae* J.C. Wei & Q.M. Zhou, were recently described from northeast China (Zhou & Wei 2006). Based on the similarity of the ascus apex structure with species of the family *Umbilicariaceae*, supported by ITS, SSU and LSU nrDNA phylogenetic analyses, Zhou & Wei (2007) placed *Rhizoplacopsidaceae* in the order *Umbilicariales* J.C. Wei & Q.M. Zhou.

After a careful examination of the holotype of *Rhizoplacopsis weichingii*, the present authors concluded that it is a synonym of *Boreoplaca ultrafrigida* Timdal, a species found in a few localities in East Siberia and Far East (Russia). Furthermore, the morphological descriptions and data on secondary metabolites of the genus and species in Timdal (1994) and Zhou & Wei (2006) are in close agreement, and coincident parts of nrDNA LSU sequences obtained from authentic material from both Yakutia (*Boreoplaca ultrafrigida*, holotype, Genbank Acc. No. AY853360; paratype, DQ986797) and Jilin (*Rhizoplacopsis weichingii*, holotype, AY530886, submitted as *Rhizoplaca orientalis*) differs in only one base (excluding gaps). Thus, the nomenclature of the genus and species should be treated as follows:

Boreoplaca Timdal, Mycotaxon 51: 503 (1994)

Type: ***Boreoplaca ultrafrigida*** Timdal

=***Rhizoplacopsis*** J.C. Wei & Q.M. Zhou, in Zhou & Wei, Mycosystema 25(3): 381 (2006)

Type: ***Rhizoplacopsis weichingii*** J.C. Wei & Q.M. Zhou.

Boreoplaca ultrafrigida Timdal, Mycotaxon 51: 503 (1994)

Type: **RUSSIA. Yakutia: Ojmyakonsskii Region**: ca. 7 km WSW of Ust'-Nera (64°32'N, 143°08'E) — 500–600 m alt., on boulder in open *Larix* forest, 10.VII.1992, Haugan, R. & Timdal, E. YAK03/39 (**holotype** O L127!).

=***Rhizoplacopsis weichingii*** J.C. Wei & Q.M. Zhou, in Zhou & Wei, Mycosystema 25(3): 381 (2006)

Type — **CHINA. Jilin: Wangqing Co.** (43°21'N, 129°46'E), on stone, 8 June 1996, Wei Jiang-chun, Jiang Yu-mei & Wang You-zhi no 45 (**holotype** HMAS-L 4918!); same locality, on rock, 9.VI.1996, Wei J. C., Jiang Y. M. & Wang Y. Z. no 140 (**paratype** HMAS-L 84923!).

Additional specimens examined — **RUSSIA. Republic Sakha-Yakutia: Ojmakonskii region,** ca. 9 km SW of Ust'-Nera (64°30'N, 143°10'E) alt. 600–800 m, 11.VII.1992, M. P. Zhurbenko 92164 (LE L61), 92159 & 92160 (LE); same region, ca. 8 km SW of Ust'-Nera, (64°31'N, 143°08'E), alt. 600–700 m, 23.VII.1992, M. P. Zhurbenko 92164 (LE); same republic, Verkhoyanskie Mts. opposite mouth of Vilyui River, (ca. 127°N 64°30'E), on stone, 1901, P. V. Olenin (LE). — **Republic Buryatia:** Khamar-Daban Range, Baikal state reserve, headwaters of the Mishikha River, Gladky Range, (51°20'N, 105°28'E) alt. ca. 2000 m, on boulders, 13.VII.1998, I. N. Urbanavichene (LE); same republic, eastern slope of Khambin Range, 8 km NE of Gusinoe Lake, Mt. Ulabortoi (51°20'N, 106°25'E) alt. 800–900 m, on open rocks among taiga forest, 31.VII.1993, M. P. Zhurbenko 9317 (LE L2404). — **Magadanskaya Oblast': Khacynskii region,** ca. 26 km S of Myakit, at the top of the pass on the road to Talaya (61°11'N, 152°06'E) alt. 1050–1100 m, 27.VII.1992, M. P. Zhurbenko 92158 (LE). – Far East, **Primorskii Kray: Lazo region,** Lazovskii state reserve, Sukhoi Log (43°02'N, 133°36'E) alt. 700 m, small ridge with open rock outcrops among taiga forest, on stone, 28.IX.1991, M. P. Zhurbenko 914 (LE, M).

The placement of *Boreoplaca ultrafrigida* in a monotypic family *Rhizoplacopsidaceae* requires further discussion. When discussing affinities of *B. ultrafrigida*, Timdal (1994) mentioned that it was difficult to find a family for the new genus. While the thallus morphology is close to species of traditional *Lecidea* sect. *Psora*, the ascus type resembles that of the *Hypocenomyce friesii*-complex, and the anatomy of the apothecium and the thallus chemistry resemble that of the *H. scalaris*-complex.

The close relationship of *Boreoplaca* to *Ophioparma* and *Hypocenomyce scalaris* was supported by molecular phylogenetic analyses based on mtSSU/nLSU rDNA (Wedin et al. 2005) and on the multilocus dataset (Miadlikowska et al. 2006). As mentioned by Wedin et al. (2005), *Boreoplaca, Ophioparma* and *H. scalaris* have similar asci. The amyloid reaction pattern of the ascus tips is a valuable taxonomic marker often correlating with molecular data within *Lecanoromycetes* (Peršoh et al. 2004). The presence of amyloid asci with a tholus

exhibiting a strongly amyloid dome in a monophyletic group, supported by the results of the molecular phylogenetic analyses, was used to suggest the extension of the family *Ophioparmaceae* R.W. Rogers & Hafellner (Miadlikowska et al. 2006). Nevertheless, the *Ophioparmaceae* needs additional investigation, since according to the cladograms presented in the above-cited publications, it may include *Ophioparma* and *Hypocenomyce scalaris*, *Ophioparma* and *Boreoplaca*, or all three taxa, the genera of which are clustered within the *Fuscideaceae-Umbilicariaceae* clade (Miadlikowska et al. 2006). However, some taxa related to *Umbilicariaceae* were not included in this study. *Elixia* forms a sister group to *Umbilicariaceae* in Bayesian analyses of nuclear and mitochondrial DNA (Lumbsch et al. 2004). Moreover, *Hypocenomyce friesii*, which has an ascus type similar to *Boreoplaca*, clusters with high support in *Umbilicariaceae* sequences (Wedin et al. 2005), but was not included to the data set by Miadlikowska et al. (2006). Consequently, the relation of *Ophioparmaceae* with *Elixia* and the *Hypocenomyce friesii*-complex remains unclear.

Despite the fact that the current family (*Rhizoplacopsidaceae* or *Ophioparmaceae*) for *Boreoplaca* seems uncertain, the placement of the genus within *Umbilicariales* as suggested by Zhou & Wei (2006) and Miadlikowska et al. (2006) and formally described in Zhou & Wei (2007) looks plausible, because phylogenetic analyses based on different genes consistently place *Boreoplaca* in the monophyletic groups sister to *Umbilicariaceae*-clade; furthermore, *Boreoplaca* has asci similar to asci in representatives of *Umbilicariaceae*.

The above work extends our knowledge of the distribution of *Boreoplaca ultrafrigida* (Fig. 1), which was previously known only from Russia: Chersky Range (NE Yakutia) (Timdal 1994), Verkchoyansky Range (LE), Southern (Urbanavichene & Urbanavichus 1999) and Eastern (Budaeva & Kharpukhaeva 2003) Baikal region, Khentei-Chikoi Upland (Urbanavichus & Urbanavichene 2002), Stanovoye Upland (Makryi 2002; Kharpukhaeva et al. 2004), and Sikhote-Alin' Range (Zhurbenko 2003). The locality in China is the most southerly finding of *B. ultrafrigida*.

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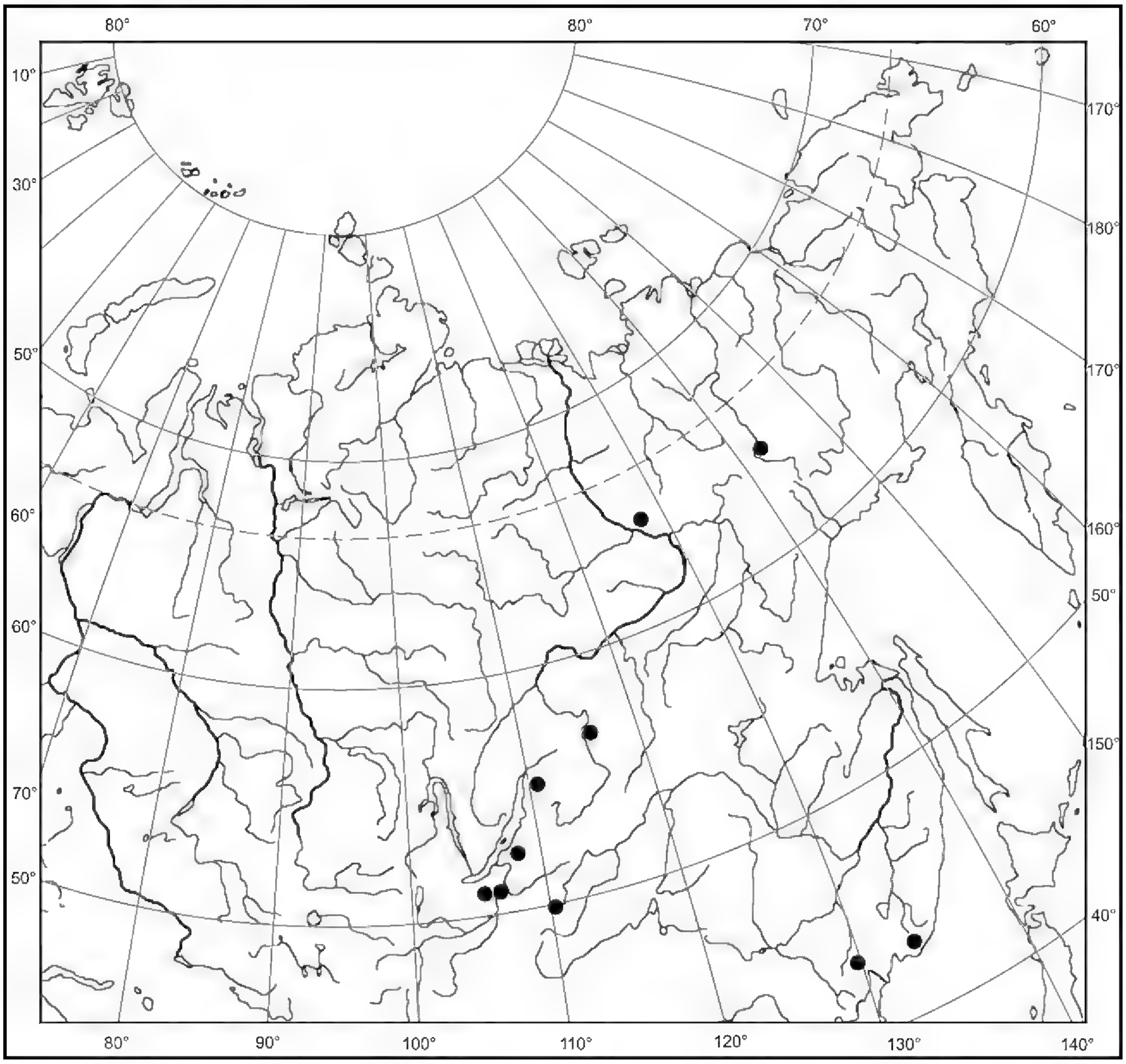

FIGURE 1. Distribution map of *Boreoplaca ultrafrigida* based on investigated specimens and literature data.

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A new species of *Mycosphaerella* associated with foliage and stem necrosis on *Phytolacca americanae*

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Abstract—The new species *Mycosphaerella americanae* (*Ascomycota*, *Mycosphaerellaceae*) associated with stem and foliage necrosis on *Phytolacca americanae* is newly described from Brazil. The spermatial state (*Asteromella*) as well as the conidial state (*Septoria*) were also collected and described.

Key words — *Ascomycetes*, coelomycetes, pleomorphic fungi, tropical fungi, weeds

Introduction

Phytolacca americanae L. (*Phytolaccaceae*) has several common names in the USA – American pokeweed, inkberry, pigeonberry, pokeweed – in Brazil it is known as fruto-de-pombo or caruru-açú. It is a widely distributed American perennial herb or small shrub. In Brazil it commonly occurs in recently deforested areas, in areas that were subjected to fires or otherwise disturbed (Lorenzi 2008). Although it is listed in the main Brazilian weed lists (Lorenzi 2008, Kissmann 2000) it is regarded as a weed of minor importance in Brazil and sometimes it is used as an ornamental for its attractive foliage and violet inflorescences. In American literature it is commonly regarded as a weed, a poisonous plant, a medicinal plant, and also (with special processing of some parts) a food. Since February 1998, a disease has been observed resulting in extensive necrosis of *P. americanae* in the highlands of the state of Rio de Janeiro (Brazil). Most observations were made in the municipality of Nova Friburgo and neighboring areas. Closer observations revealed the presence of minute

black fruiting bodies associated with necrotic tissues. This publication provides an account of the fungus associated with this disease.

Material and methods

Selected diseased parts of *P. americanae* were collected and dried in a plant press for later examinations and deposit in the local herbarium – Herbário da Universidade Federal de Viçosa (Herbarium VIC). Sections of leaf fragments bearing fungal structures were prepared with a microtome cryostat HM 520 Microm and slides were mounted in lacto-fuchsin or lactophenol. Observations, measurements, and illustrations were made using a light microscope Olympus BX 51 fitted with a drawing tube and a digital camera Olympus BX E330.

Taxonomic description

Mycosphaerella americanae B.V. Lima, R.W. Barreto & D.J. Soares, **sp. nov.**
Mycobank mb 512636 (figs 1-7)

Macullae amphigenae, albidae, cum margine nigrae incrassatae elevatae. Spermogonie pycnidial, globosa, 26–60 × 28–77 µm. Spermatia globosa vel oblonga, 2.5–6.5 × 1.3– 2.5 µm. Ascomata singularia, 41–109 × 45–125 µm, asci 35–49 × 9–13 µm. Ascosporae 10–15 × 2.5–4 µm. Conidiomata pycnidial. Cellulae conidiogenae ampulliformis vel subcylindricae, 6–25 × 3–6 µm hyalinae. Conidia cylindrica, pluriseptata, 20–42 × 2–3 µm, hyalina.

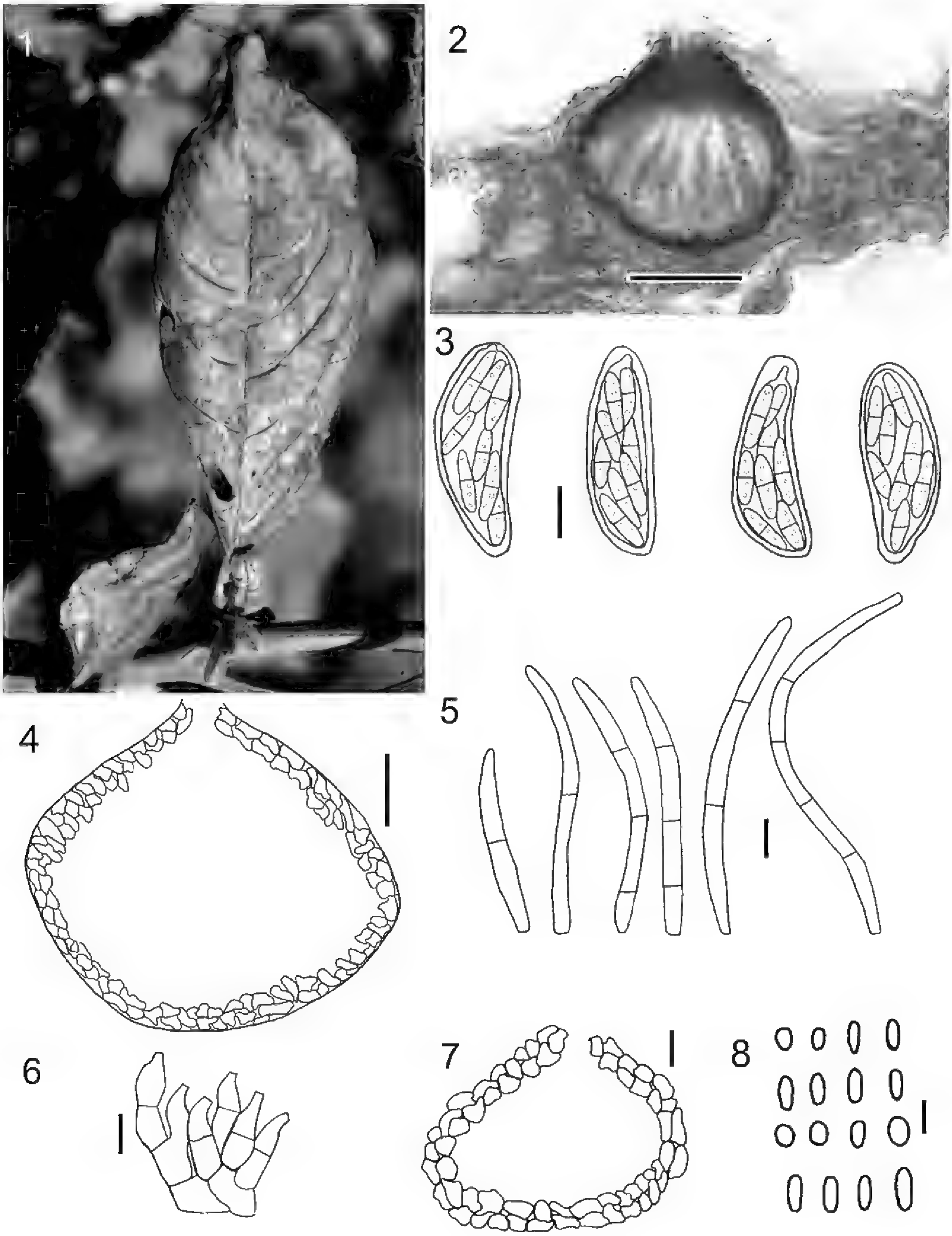
Type: Brazil. Rio de Janeiro: Nova Friburgo - on *Phytolacca americanae*, April 2008, R.W. Barreto 876 (**Holotype** VIC 30712).

Spermatial state: *Asteromella* sp.

Anamorph: *Septoria* sp.

Etymology: based on the specific epithet of the host.

Lesions on living leaves and stems; on leaves lesions starting as necrotic dots becoming circular to elliptical, 1.8–12 × 1.5–14 mm, gray with concentric zonation and brown margins; on stems lesions are necrotic, elliptic and sunken. Spermogonia pycnidial, globose, 26–60 × 28–77 µm, walls 4–11.5 µm thick composed of pale brown textura angularis; spermatiospores globose to oblong, apices rounded, 2.5–6.5 × 1.3– 2.5 µm, hyaline. Pseudothecia hypophyllous, globose, semi-immerse, isolate, 41–109 × 45–125 µm, walls composed of textura angularis pale to dark brown, 2–3 cells, 4–19 µm thick; dehiscence ostiolate, central, circular, 6.5–32 µm diam.; asci bitunicate, fasciculate, sub-cylindrical, ellipsoidal to slightly obclavate, 34.5–50 × 9–13 µm; ascospores fusiform with rounded apices inordinate to biseriate, 10–15 × 2.5–4 µm, one-septate, hyaline, guttulate. Conidiomata (scarce in the available specimens) pycnidial, globose, pale brown; conidiogenous cells holoblastic, ampulliform, lageniform to subcylindrical, 6–25 × 3–6 µm, septate, hyaline; conidia filiform, straight to sigmoid, 20–41.5 × 2–3 µm, 1–5 septate, hyaline.



Figs. 1–8. *Mycosphaerella americanae* on *Phytolacca americana*. 1. Leaf spot symptoms; 2. Transversal section of infected leaf showing a pseudothecium; 3. Asci and ascospores; 4. Pycnidium of the *Septoria* anamorph of *M. americanae*; 5. Conidia of *Septoria* sp.; 6. Conidiogenous cells of *Septoria* sp.; 7. Spermatial stage of *M. americanae*; 8. Spermatiospores.

Scale bars: 2 = 50 µm; 3 and 7 = 10 µm; 4 = 20 µm; 5, 6 and 8 = 5 µm.

Addition specimen examined (Paratype): Brazil. Rio de Janeiro: Nova Friburgo - on *Phytolacca americanae*, February 1998, R.W. Barreto 44 (VIC 30711).

Comments —*Mycosphaerella* is a very large genus containing around 647 species (Kirk et al 2008) associated with numerous host genera. Previously, the only species in the genus known to associate with the *Phytolaccaceae* has been *Mycosphaerella circe* (Sacc.) Tomilin, which was described on *P. decandra* L. in Italy (Saccardo 1882: 512). *Mycosphaerella americanae* is easily separated from *M. circe* by having narrower ascospores (5-6 µm diam.) as well as associating with a different host species. As for the conidial state of the fungus, a more complicate situation exists.

There are four different species of *Septoria* described in association with the *Phytolaccaceae*, namely: *S. pamparum* Speg. on *Pircunia dioica* (L.) Moq. in Argentina; *S. phytolaccae* Cavara on *P. decandra* in Italy; *S. patouillardii* Sacc. & P. Syd. on *Phytolacca* sp. in Equador and *S. rivinae* Pat. on *Rivina octandra* L. in Central America (Farr et al. 2008, Mendes et al. 1998, Viégas 1961). Another species of *Septoria* that was described on a *Phytolacca* species is *Septoria phlyctaenoides* Berk. & M.A. Curtis. However, *S. phlyctaenoides* was later transferred to *Phlyctema* (Saccardo 1884: 594, as "*Phlycaena septorioides*").

Both *S. phytolaccae* and *M. circe* have been reported from the same host (*P. decandra*) in northern Italy and this may represent an unreported anamorph-teleomorph connection. *Septoria phytolaccae* is similar to the anamorph of *M. americanae* but its conidia are longer and narrower (45–55 × 2 µm) (Saccardo 1895: 545). *Septoria pamparum* has shorter and narrower conidia (12–15 × 1–1.5 µm) and was reported on *P. dioica* (Saccardo 1884: 554). *Septoria rivinae* has longer conidia (45–60 µm) and was reported on a different genus (Saccardo & Trotter 1913: 1112-1113). *Septoria patouillardii* is rather close to the anamorph of *M. americanae* but it has shorter conidia (20–23 µm) and its conidia have only 1-3 septa (Saccardo & Sydow 1899: 969). Data on both anamorphic and teleomorphic states of the *Mycosphaerella* newly described are therefore sufficiently different from related taxa to justify the proposal of a new species.

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Status of the genera *Hymenangium* and *Descomyces*

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Abstract — Uncertainty in contemporary literature concerning the status of *Hymenangium* and *Descomyces* is addressed. Typification of *Hymenangium* and the nomenclatural confusion regarding *H. album* are clarified. Suggestions in the current Dictionary of Fungi that *Descomyces* be conserved against *Hymenangium* are discounted, and the author proposes that the entry for *Hymenangium* ("*Hymenangium* Klotzsch (1839) = *Descomyces*") be corrected to "*Hymenangium* Klotzsch (1838) = *Rhizopogon*," to reflect Klotzsch's erection of *Hymenangium* for a *Rhizopogon* species (*H. virens*). In 1839 Klotzsch cited a J.D. Hooker specimen as a second species of *Hymenangium*, but misapplied *Tuber album* Bull. to serve as a reference for its name *Hymenangium album*. For *Descomyces*, the epithet *albus* should not be ascribed to Klotzsch but rather to Berkeley, who described *Hymenogaster albus* in 1844 based on the same Hooker collection annotated by Klotzsch. As Berkeley delimited the original type by excluding all other elements ('exclusis omnibus synonymis'), under Art. 48.1 he established a valid new species for which *Descomyces albus* (Berk.) Bougher & Castellano should be regarded as the correct name. Conservation of the later-named *Rhizopogonaceae* against *Hymenangiaceae* may be needed.

Key words—*Agaricales*, *Cortinariaceae*, taxonomy

Introduction

The genus *Descomyces* was proposed by Bougher & Castellano (1993) to accommodate gastroid fungi with morphologies (peridium, veil, spore, and mycorrhiza) matching those of the agaricoid genus *Descolea* and the secotioid genus *Setchelliogaster*. Phylogenetic analyses of molecular sequences have supported the proposition of a *Descolea*-*Setchelliogaster*-*Descomyces* complex (Peintner et al. 2001).

Bougher & Castellano (1993) transferred three species from the genus *Hymenogaster* into *Descomyces* and nominated "*Descomyces albus* (Klotzsch) Bougher & Castellano" as the type species. Four additional species of *Descomyces* have been published (Giachini et al. 2000, Francis & Bougher 2004, Nouhra et al. 2008). However, the genus name *Descomyces* has not gained universal

acceptance in the contemporary literature due to doubts concerning the status of the type species *Descomyces albus* and particularly its supposed basionym "*Hymenangium album* Klotzsch." Some authors have adopted *Hymenangium* in preference to *Descomyces*, e.g. Legon & Henrici (2005), Pegler et al. (1993), and Roberts (2000). Such authors presumably accept that *Hymenangium album* as proposed by Klotzsch (1839) is the valid type species of *Hymenangium* and that therefore the generic name *Descomyces* is nomenclaturally superfluous. Some other authors (e.g. Montecchi & Sarasini 2000) have stated a desire for further clarification about the correct genus name and have avoided using either name by referring to *Hymenangium album/ Descomyces albus* as "*Hymenogaster albus* (Klotzsch) Berk."

Martín (1999) examined the status of *Hymenangium album* and proposed that this name and its basionym "*Rhizopogon albus* Fr." do indeed refer to *Descomyces albus*. However, several aspects of Martín's conclusions are incorrect with regard to the ICBN. Martín (1999) also did not address the issue of whether *Hymenangium album* validly can be accepted as a basis to typify *Hymenangium* or *Descomyces*. Bougher & Castellano (1993) had previously argued that *Hymenangium album* cannot be accepted as the type species for *Hymenangium* because *Hymenangium* Klotzsch 1838 is typified by *H. virens* (Alb. & Schwein.) Klotzsch (basionym *Tuber virens* Alb. & Schwein.). However, that conclusion has been overlooked by all mycologists, including in the most recent Dictionary of Fungi (Kirk et al. 2008). The dictionary entry for *Descomyces* includes: "*Descomyces* is not yet conserved against *Hymenangium*." The entry for *Hymenangium* is: "*Hymenangium* Klotzsch (1839) = *Descomyces*. *Descomyces* is not yet conserved against *Hymenangium*, fide Kuyper (in litt.)." This current paper addresses issues concerning the typification of *Hymenangium* in order to clarify the status of that genus and to determine if indeed it is necessary to conserve the genus *Descomyces*.

Taxonomy

In 1838, F. Klotzsch proposed *Hymenangium* as a new monotypic genus based on *Tuber virens* (Klotzsch 1838). The generic description and Klotzsch's illustration of *Hymenangium virens* Klotzsch depict a fungus with quadrisporic basidia. Klotzsch (1838) listed the following taxonomic synonyms under *Hymenangium virens*: (a) "*Tuber virens* Albertini et Schweinitz;" (b) "*Rhizopogon virens* Fries;" (c) "*Tuber album* Albertini et Schweinitz." Klotzsch did not accept Albertini & Schweinitz's *T. album* as a species distinct from *Tuber virens*. Based on recombinations by Fries (1823), later authors accepted Albertini & Schweinitz's *Tuber album* under *Rhizopogon*. Saccardo (1888) designated Albertini & Schweinitz's *Tuber album* and Klotzsch's *Hymenangium virens* under *Rhizopogon rubescens* (Tul. & C. Tul.) Tul. & C. Tul.

and placed Albertini & Schweinitz's *Tuber virens* and *Rhizopogon virens* under *Rhizopogon luteolus* Fr. There is, in my opinion, no doubt that *T. virens* refers to a species of *Rhizopogon*. Therefore *Hymenangium* becomes a taxonomic synonym of *Rhizopogon*. The entry in the Dictionary needs correction. Note that this conclusion also implies that the family name *Hymenangiaceae* (Corda 1842) now becomes an (older) name for *Rhizopogonaceae* (Gäumann & Dodge 1928) so conservation could be necessary. It needs to be noted that Bougher & Castellano (1993: 275) erroneously listed *Hymenangium* as a taxonomic synonym of *Hymenogaster*, which contradicted their recognition (p. 285) that *Hymenangium* as typified by *H. virens* represents *Rhizopogon*.

A year after first proposing *Hymenangium* for *H. virens*, Klotzsch (1839) emended the generic description to accommodate a second fungus — *Hymenangium album*, for which he listed the synonyms (a) "*Rhizopogon albus* Fries (excl. Albertini et Schweinitz syn.);" (b) "*Lycoperdon gibbosum* Dickson;" (c) "*Tuber album* Bulliard." As noted by Saccardo (1888), this second *Hymenangium* species is not the same fungus as Albertini & Schweinitz's *Tuber album* previously listed by Klotzsch (1838) as a synonym of *H. virens*. Rather, according to Martín (1999), it represents *Tuber album* Bull. (Bulliard 1791), part of which she refers to *Tuber borchii* Vittad. and part possibly to a *Balsamia* species. The name *Tuber album* actually dates from Bulliard (1789), who published it in the caption of his illustration of the taxon.

Klotzsch's emended generic description of *Hymenangium* includes descriptors applicable to both *H. virens* and *H. album*, e.g., by accommodating fungi having quadrisporic and bisporic basidia respectively (Klotzsch 1839). Soon after, Corda (1842) proposed the new family *Hymenangiaceae*, re-affirming in the process that Klotzsch's *Hymenangium* included quadrisporic and bisporic fungi and that Klotzsch first circumscribed the genus in 1838 in Flora Regni Borussici (6: 382).

It is clear that Klotzsch (1839) intended not to describe a new species but to apply the name of an existing species (Bulliard's *Tuber album*) to his concept. Technically, therefore, there is no "*Hymenangium album* Klotzsch" – even though the name consistently appears in the literature listing Klotzsch as basionym author instead of the correct *H. album* (Bull.) Klotzsch. Furthermore, his 1839 description leaves no doubt that Klotzsch misapplied the original Bulliardian name. This raises the question as to which taxon Klotzsch actually examined. Klotzsch cited two collections, both from the Berlin vicinity — his own found growing near *Calluna vulgaris* and *Pyrola* and another from the Berlin Botanical Garden. Klotzsch's text might suggest that he found his fungus in a heathland ("between *Calluna vulgaris*") except that the mention of *Pyrola* (a partial mycoheterotrophic plant that derives carbon from ectomycorrhizal connections) implies the presence of ectomycorrhizal trees (most likely *Pinus*)

in the vicinity. Unfortunately, neither Berlin collection survives. Nonetheless, because *Descomyces albus* is an exclusive associate of *Myrtaceae* (particularly *Eucalyptus*), it is likely that Klotzsch's own collection represents not *Descomyces* but a species of *Rhizopogon*. The identity of the specimen found in the Botanical Garden remains unknown.

In his description of *H. album,* Klotzsch (1839) also cited (with an exclamation mark) a description by Berkeley (1836: 229). This collection was made in a greenhouse in Glasgow in 1830 by Joseph Dalton Hooker (son of W.J. Hooker, then Regius Professor of Botany in Glasgow). Klotzsch annotated the Hooker collection, which is still held at Kew, where he worked between 1830 and 1832. This specimen undoubtedly represents the species now referred to *Descomyces albus*, as supported by the accurate descriptive details provided by Berkeley (1836) of the Glasgow collection that Berkeley later (1844) cited when describing *Hymenogaster albus*. It should be noted that Bougher & Castellano (1993) incorrectly listed "*Hymenogaster albus* (Klotzsch) Berk. & Br." instead of "*Hymenogaster albus* (Klotzsch) Berk." in their synonymy for *Descomyces albus*. It now seems certain that the Glasgow collection held at Kew matches Klotzsch's 1839 illustrations of the *H. album* fruit body, basidia and spores and was the specimen seen and annotated by Klotzsch (Pegler et al. 1993).

Klotzsch did not introduce a new species but rather misapplied Bulliard's name *Tuber album* to the collection he examined. There is therefore no basis for citing Klotzsch as an author of *Hymenangium album, Hymenogaster albus,* or *Descomyces albus*. Furthermore, if *Descomyces* were to be typified by *Hymenangium album* "Klotzsch," the name *Descomyces* could not be maintained.

Bougher & Castellano (1993) typified *Descomyces* by Hooker's Glasgow collection, then labeled as *Hymenogaster klotzschii* Tul. & C. Tul. 1851. *Hymenogaster klotzschii,* however, represents an illegitimate superfluous name for a species already named by Berkeley. Berkeley (1836), who initially named the species *Rhizopogon albus* based on his own observations, later referred it to *Hymenogaster albus* based on the Hooker collection at Kew (Berkeley 1844). As Berkeley (1844) explicitly excluded all other elements including the original type by his statement 'exclusis omnibus synonymis,' under Art. 48.1 his name is considered valid for a new species. For this reason, *Hymenogaster albus* Berk. (rather than the more commonly cited "*Hymenogaster albus* (Klotzsch) Berk.") serves as basionym for *Descomyces albus* (Berk.) Bougher & Castellano, the type of *Descomyces*.

Taxonomic and nomenclatural conclusions

There is no need to conserve *Descomyces* against *Hymenangium*. *Hymenangium virens* as presented by Klotzsch (1838) is the type species for *Hymenangium*.

Both it and the synonyms Klotzsch (1838) listed — "*Tuber virens* Albertini et Schweinitz," "*Rhizopogon virens* Fries," "*Tuber album* Albertini et Schweinitz" — represent species of *Rhizopogon*. Accordingly, *Hymenangium* is a synonym of the earlier-named (by E. Fries in 1817) genus *Rhizopogon*. The current entry for *Hymenangium* in Kirk et al. (2008) — "*Hymenangium* Klotzsch (1839) = *Descomyces*" — should be corrected to "*Hymenangium* Klotzsch (1838) = *Rhizopogon*." Conservation of the later named *Rhizopogonaceae* against the earlier named *Hymenangiaceae* might be needed, however.

The '*Hymenangium album*' specimen (Hooker's collection from Glasgow) examined by Klotzsch was available to be selected by Bougher & Castellano (1993) to serve as type species of the genus *Descomyces* with the valid name *Hymenogaster albus* Berk. as basionym based on Berkeley's 1844 description; Klotzsch's name '*Hymenangium album*,' however, is a misapplication to be ignored. The correct author citation under *Descomyces* is, therefore, *D. albus* (Berk.) Bougher & Castellano.

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Checklist of the aphyllophoraceous fungi (*Agaricomycetes*) of the Brazilian Amazonia

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Abstract — A literature-based checklist of the aphyllophoraceous fungi reported from the Brazilian Amazonia was compiled. Two hundred and sixteen species, 90 genera, 22 families, and 9 orders (*Agaricales*, *Auriculariales*, *Cantharellales*, *Corticiales*, *Gloeophyllales*, *Hymenochaetales*, *Polyporales*, *Russulales* and *Trechisporales*) have been reported from the area. A summary of the data in the checklist is presented here and the checklist is available at http:/www.mycotaxon.com/resources/weblist.html.

Key words — macrofungi, neotropics

Introduction

The aphyllophoraceous fungi are currently spread througout many orders of *Agaricomycetes* (Hibbett et al. 2007) and comprise species that function as major decomposers of plant organic matter (Alexopoulos et al. 1996).

The Amazonian Forest (00°44'–06°24'S / 58°05'–68°01'W) covers an area of 7 × 10^6 km^2 in nine South American countries. Around 63% of the forest is located in nine Brazilian States (Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, west of Maranhão, and north of Mato Grosso) (Fig. 1). The Amazonian forest consists of a mosaic of different habitats, such as open ombrophilous, stational semi-decidual, mountain, "terra firme," "várzea" and "igapó" forests, and "campinaranas" (Amazonian savannahs). Six months of dry season and six month of rainy season can be observed (Museu Paraense Emílio Goeldi 2007).

Even with the high biodiversity of Amazonia and the well-documented importance of aphyllophoraceous fungi to all arboreous ecosystems, few studies have been undertaken in the Brazilian Amazonia on this group of fungi (Bononi 1981, 1992, Capelari & Maziero 1988, Gomes-Silva et al. 2008, Jesus 1996, Martin-Júnior et al. 2008, Sotão et al. 1997, 2002, 2008). This work aims to contribute to the knowledge about the diversity of the aphyllophoraceous

FIGURE 1. The nine Brazilian States (Acre - AC, Amazonas - AM, Amapá - AP, Pará - PA, Rondônia - RO, Roraima - RR, Tocantins - TO, west of Maranhão - MA, and north of Mato Grosso - MT) where the Brazilian Amazonia is found.

fungi in this high diverse biome by compiling and updating the nomenclature of published records of aphyllophoraceous fungi from the Brazilian Amazon.

Material and methods

All available publications with records of aphyllophoraceous fungi (*Agaricomycetes*) collected in the Brazilian Amazonia were examined. The reports were compiled and the nomenclature of the listed species were checked against and — when necessary— updated following the classification of Index Fungorum (http://www.indexfungorum.org/Names/Names.asp) and CBS (http://www.cbs.knaw.nl/databases/). Taxa with unresolved nomenclature according to the consulted databases and those lacking neo- or pantropical distributions were excluded. The occurrence and distribution of the species in Brazilian states were recorded. The checklist is organized in alphabetical order by families, genus, and species.

Results and discussion

Currently, 216 species of aphyllophoraceous fungi previously recorded from the Brazilian Amazonia are included in the checklist. These species are at present distributed in 90 genera, 22 families, and 9 orders (*Agaricales*, *Auriculariales*, *Cantharellales*, *Corticiales*, *Gloeophyllales*, *Hymenochaetales*, *Polyporales*, *Russulales* and *Trechisporales*). *Polyporales* has the higest number of species (144), families (7), and genera (61). Among the families, *Polyporaceae* is the most species rich (79), followed by *Hymenochaetaceae* (32), and *Meruliaceae* (29). *Botryobasidiaceae*, *Cantharellaceae*, *Corticiaceae*, *Cystostereaceae*, *Meripilaceae*, *Peniophoraceae*, *Schizophyllaceae* and *Schizoporaceae* are each represented by one species. Among the genera, *Amauroderma* (16), *Phellinus* (15), *Trametes* (14), *Hymenochaete* (8), *Polystictus* (7), *Ganoderma* (7), and *Podoscypha* (7) have the highest number of species. *Phellinus gilvus* (Schwein.) Pat. and *Earliella scabrosa* (Pers.) Gilb. & Ryvarden have been recorded in all states of the Brazilian Amazonia. The State of Pará is represented by 126 species (58%), with 53 exclusive to the State. The State of Amazonas has 86 reported species (35 exclusive) and 35 species were recorded from the State of Roraima (15 exclusive). The states of Rondônia and Acre recorded 48 and 28 species respectively, each with 7 exclusive species and the states of Mato Grosso and Amapá recorded 36 and 23 species respectively, each with 6 exclusive species. Of the excluded species, all of which should have their exsiccates reviewed, 22 were excluded due to their non neo- or pantropical distribution and 65 due to nomenclature uncertainties according to the consulted databases.

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Calvatia oblongispora sp. nov. from Brazil, with close affinities to *C. sporocristata* from Costa Rica

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Abstract — A new species of *Calvatia* from Manaus in Amazonas State, Brazil, is proposed, which is very close to *Calvatia sporocristata,* recently described from Costa Rica. The two species have been compared macroscopically and examined using light and scanning electron microscopy. The proposed new species, *C. oblongispora,* possesses a distinctly two-layered exoperidium consisting of a hyphal outer layer and an inner pseudoparenchymatous layer. This contrasts to the single pseudoparenchymatous exoperidium possessed by *C. sporocristata*. A table comparing the main exoperidial, basidiospore, and capillitial differences between both species is provided.

Key words — *Lycoperdaceae,* taxonomy, morphology, SEM, gasteromycetes

Introduction

During a taxonomic survey of the species of *Calvatia* from South America, a collection from INPA, at Manaus, State of Amazonas, Brazil, was studied that we were unable to match with current reference publications (Zeller & Smith 1964 Kreisel 1992, 1994; Lange 1990, 1993; Moreno & al. 1996 Ochoa & al. 1998 Calonge & al. 2003). In their study of phylogenetic relationships among the *Lycoperdaceae* from North Europe, Larsson & Jeppson (2008) included six species of *Calvatia* in their sequence data analyses. [The current (10th) edition of the Dictionary of the Fungi (Kirk & al. 2008) recognizes about 40 taxa.]

Materials and methods

For the study of the gastrocarp, basidiospores, and capillitium, we followed the methods described by Wright & Suárez (1990). Scanning electron micrographs were taken using a Phillips SEM 515 belonging to the Centro de Investigaciones Tecnológicas de las Fuerzas Armadas (CITEFA) and a Hitachi S-3000N SEM

belonging to Real Jardín Botánico de Madrid (CSIC). Examinations under the light microscope (LM) followed standard techniques using 5% KOH solution as the moisturizing agent. Herbarium abbreviations follow Holmgren & al. (1990).

Results

Calvatia oblongispora V.L. Suárez, J.E. Wright & Calonge **sp. nov.** (Figs. 1a, d)
MycoBank MB513105

Gastrocarpus globosus vel subglobosus, ca. 8–10 cm diam. Peridium bistratosus, tenue, facile secedentibus, fragilissimus, laeve, compactus, flavus vel ochraceus, rugosus, rhizomorphus mycelianus ornatus, usque ad 5 mm long. Gleba gossipino-compacta, ad centrum brunneo-flava, versus peridium concoloribus. Subgleba alveolata, prominens, concoloribus, ca. 2.5–3 cm alt.

Sporis cylindrico-ellipsoideis vel longe ovoideis, hyalinis, echinulatis, 5.4–7.5 × 3.6–4.3 μm, mucronatis, mucro 1 μm long, ornamentatione sub SEM echinulis in cristae anastomosantibus meridianis exornatis.

***Holotypus:** Brazil: Amazonas, Manaus, leg. Singer nº 10.605, 4-II-1978 in herb. INPA nº 82-826 conservatus est.*

Basidioma globose to subglobose, ca. 8–10 cm diam. Peridium thin, easily detachable from the gleba, fragile, crumbling, smooth, tightly felty-appressed, light beige, wrinkled, with a small, short, thin mycelium cord, 5 mm long; double, formed by two distinct layers: a) exoperidium, with an outer hyphal layer, 50–100 μm thick, formed by hyaline, intertwined, septate, branched hyphae, without pores, up to 7 μm thick, and an inner one of pseudoparenchymatous, hyaline, thin-walled cells, 13.5–54 × 13.5–40.5 μm; b) endoperidium formed by septate, dichotomously branched hyphae without pores, 1.5–7.2 μm diam, walls up to 0.7μm thick. Gleba cottony subcompact, with light yellow to brownish yellow centre. Subgleba cellular, prominent, concolorous with the glebal centre, ca. 2.5–3 cm high.

Spores cylindrico-ellipsoid, hyaline, echinulate, uniguttulate, 5.4–7.5 × 3.6–4.3 μm. The ornamentation appears as spines arranged along longitudinal cristae in single or dichotomous fringes, other times in less obvious meridian disposition (Fig. 1a) Capillitium light brown, formed by fragile, profusely septate threads, breaking at the septa, with blunt ends and with irregularly and variously sized pores (Fig. 1d), somewhat larger than 1 μm diam., but never reaching 2 μm diam. The capillitium shows Y branches of 1.5–4 μm diam., with walls up to 0.4 μm thick.

Discussion

The type and only specimen studied is a single, ill-preserved specimen, easily broken on handling. The fact that the gleba is not homogeneously coloured

suggests that the material was immature upon collecting. Under the LM the gleba also exhibits hyaline hyphal elements, possibly from the central tissue.

The specimen is characterized by its felty, very fragile peridium, presence of a distinct cellular subgleba, capillitium with medium to large pores, oblong to ellipsoid, echinulate spores under the LM, which appear with spines arranged forming cristae and greatly resembling those of *Calvatia sporocristata* Calonge (Calonge et al. 2003). The ends of the capillitium threads coincide with those of *C. cretacea* (Berk.) Lloyd and *C. horrida* M. Lange (Lange 1990). According to Kreisel (1994) the new species would belong to *Calvatia* section *Calvatia*, which contains 10 species so far. However, the spore ornamentation of our collection does not match any of these. Thus, we agree with Calonge et al. (2003) to include this new taxon within section *Sporocristata* Calonge.

On the other hand, the main differences between the new species *C. oblongispora* and *C. sporocristata* are as follows: The exoperidium of *C. oblongispora* shows two layers, an outer hyphal, and an inner one of pseudoparenchymatous structure, while in *C. sporocristata* it has only one pseudoparenchymatous layer (Table 1).

The spores are morphologically similar in both but slightly bigger in *C. oblongispora* and cylindrical (Fig. 1a), whereas they appear elliptical in *C. sporocristata* (Figs. 1b, 1c). The capillitium shows irregular and variously sized pores in *C. oblongispora*, while pores are lacking in *C. sporocristata* (Table 1).

Table 1: Primary characters differentiating *Calvatia oblongispora* from *Calvatia sporocristata.*

	C. oblongispora	*C. sporocristata*
Exoperidium	Two layers: outer hyphal, inner pseudoparenchymatous	One layer: pseudoparenchymatous
Spores	5.4–7.5 × 3.6–4.3 µm, cylindrical.	4–6 × 2.5–3.5 µm, elliptical.
Capillitium	With pores	Without pores

Less closely related but similar species include *Calvatia longicauda* (Henn.) Lloyd and *C. agaricoides* Dissing & M. Lange, both of which show an agaricoid shape with a distinct pseudostipe, two-layered exoperidium, and spores that are ellipsoid and echinulate spores but have spines not aligned in crests (Dissing & Lange 1962). A third similar species, *C. ochrogleba* Zeller, has the same morphology but produces spherical, spiny, spores without crests (Zeller 1947 Zeller & Smith 1964).

In conclusion, we consider that the combination of a two-layered exoperidium, spores with spines aligned in crests, and a pored capillitium supports the proposal of *C. oblongispora* as a new species.

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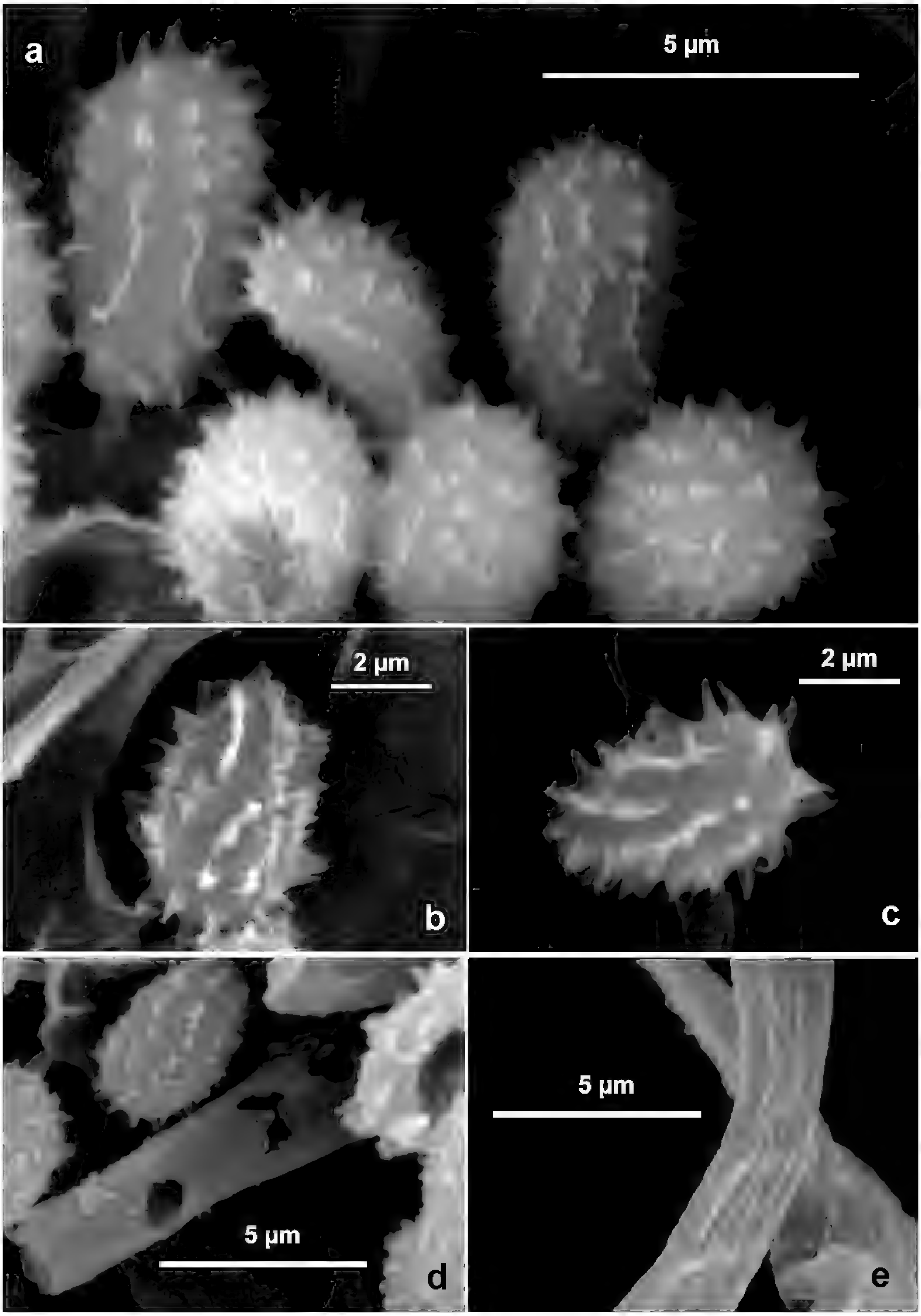

Fig. 1. **a:** *Calvatia oblongispora*. Morphology of the spores as seen under the SEM. **b, c:** *Calvatia sporocristata*. Morphology of the spores as seen under the SEM. **d:** Capillitium of *C. oblongispora* with pores. **e:** Capillitium of *C. sporocristata* without pores.

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Antrodia serialiformis from the eastern USA, a new and abundant polypore similar to *A. serialis*

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Abstract — A new and common polypore *Antrodia serialiformis* from eastern USA is described. The species is similar enough to *A. serialis* that previously both species were probably confused, but *A. serialiformis* seems exclusively confined to oaks. We present evidence that the new species differs from *A. serialis* based on much smaller basidiospores, mating incompatibility, rDNA sequence differences, and ecology.

Key words — taxonomy, brown-rot polypore, *Basidiomycota*, North America.

Introduction

Nearly all trees and herbaceous plants as well as some agaricoid fungi (Vilgalys 1991) native to the eastern USA represent species different from those described from Europe. Similarly looking "twin species" are frequent, reflecting evolution from common ancestors. In contrast, approximately 75% of temperate zone polypores represent species that have been regarded as the same on both continents (Gilbertson & Ryvarden 1986, 1987). Not surprisingly, the advent of recombinant DNA technology has uncovered new American polypore twin-species that differ from those found in Europe (Miettinen et al. 2006). In this paper, we present evidence that a polypore similar to *Antrodia serialis* (Fr.) Donk, very common on oak logs in Pennsylvania, Maryland, Virginia, North Carolina, Tennessee and probably other US southeastern states, is a related but distinct species named here *Antrodia serialiformis.*

Materials and methods

Specimens

We collected 31 specimens from the eastern USA during 2001, 2003, 2005, 2007, and 2008. Pieces of dried basidiocarps mounted in 5% KOH solution or Melzer`s

TABLE 1. *Antrodia serialiformis* specimens examined.

SPECIMEN	*	LOCALITY	COLLECTED
JV0108/11	*s*	French Creek St. Park, Hopewell, PA, USA	2. VIII. 2001
JV0108/12a	*f*	French Creek St. Park, Hopewell, PA, USA	2. VIII. 2001
JV0108/13a,b	*f*	French Creek St. Park, Hopewell, PA, USA	2. VIII. 2001
JV0108/118a	*s*	Ralph Stover St. Park, Point Pleasant, PA, USA	21. VIII. 2001
JV0109/C3-J	*s*	Shenandoah Nat. Park, Front Royal, VA, USA	19. IX. 2001
JV0308/35	*f*	Evansburg St. Park, Norristown, PA, USA	28. VIII. 2003
JV0308/36	*s*	Evansburg St. Park, Norristown, PA, USA	28. VIII. 2003
JV0308/37	*s*	Evansburg St. Park, Norristown, PA, USA	28. VIII. 2003
JV0308/38	*s*	Evansburg St. Park, Norristown, PA, USA	28. VIII. 2003
JV0309/98	*s*	Ricketts Glen St. Park, Wilkes-Barre, PA, USA	11. IX. 2003
JV0309/113	*s*	Ralph Stover St. Park, Point Pleasant, PA, USA	16. IX. 2003
JV0309/153	*s*	Tuckahoe St. Park, Hillsboro, MD, USA	20. IX. 2003
JV0309/154	*s*	Tuckahoe St. Park, Hillsboro, MD, USA	20. IX. 2003
JV0402/5-J	*s*	Elkneck St. Park, Elktown, MD, USA	10. II. 2004
JV0404/13-J	*s*	Boogerman Trail, Great Smoky Mt., NC, USA	9. IV. 2004
JV0404/26-J	*f*	Nat. Historical Park, Harpers Ferry, MD, USA	18. IV. 2004
JV0508/27	*s*	Valley Forge, Norristown, PA, USA	31. VIII. 2005
JV0509/96	*f*	Abrams Falls, Great Smoky Mt., TN, USA	8. IX. 2005
JV0509/124	*s*	Promised Land St. Park, Pike County, PA, USA	13. IX. 2005
JV0709/15	*f*	Wissahickon Creek, Philadelphia, PA, USA	1. IX. 2007
JV0709/186	*s*	Spring Mt., Schwenksville, PA, USA	24. IX. 2007
JV0709/187	*s*	Spring Mt., Schwenksville, PA, USA	24. IX. 2007
JV0709/187A	*s*	Spring Mt., Schwenksville, PA, USA	24. IX. 2007
JV0808/47	*Wf*	Wissahickon Creek, Philadelphia, PA, USA	31. IX. 2008
JV0809/29	*Sf*	Spring Mt., Schwenksville, PA, USA	4. IX. 2008
JV0809/124	*s*	Spring Mt., Schwenksville, PA, USA	22. IX. 2008
JV0809/126	*s*	Spring Mt., Schwenksville, PA, USA	23. IX. 2008
JV0809/127	*s*	Spring Mt., Schwenksville, PA, USA	23. IX. 2008
JV0809/128	*s*	Spring Mt., Schwenksville, PA, USA	23. IX. 2008
JV0809/130	*s*	Green Lane County Park, PA, USA	23. IX. 2008
JV0809/132	*Gf*	Green Lane County Park, PA, USA	23. IX. 2008

* One-capital letter names *W, S, G* indicate specimens used for mating experiments.
Specimens labeled *f* are fertile, specimens *s* sterile or with very rare spores.

reagent were examined microscopically and 30 basidiospores from each specimen were measured. Single-basidiospore isolate (SBI) cultures were obtained from three dried two-month-old specimens from different Pennsylvania localities (labeled G, S, W, see TABLE 1). All specimens are deposited in the private herbarium of the senior author (http://mykoweb.prf.jcu.cz/polypores), with two split collections housed in PRM. The mycelial cultures are maintained at the Biology Centre of the Academy of Sciences of the Czech Republic.

Cultivation of monosporic mycelia and isolation of SBI

Sporocarp blocks ~5 mm thick containing the upper part of tubes were cut with a sterile scalpel, extracted with 500 μl of sterile water for five minutes at room

temperature, and diluted 100× with sterile H_2O. 20 µl of diluted spore suspension was plated on 3 10-cm plates with 3% malt extract FLUKA (Cat. No. 70167) supplemented with 1.5% agar. Plates were incubated at room temperature in low-light conditions. The spores germinated in 6 days. Approximately 6 germinating spores from each specimen were picked out singly and transferred to 6-cm plates with the same medium. After 7 days, the isolates were checked for typical microscopic features and absence of clamp connections. Oxidase tests were performed according to Kaarik (1965). Selected isolates were then transferred into test tubes with malt agar medium.

Compatibility tests

Petri dishes (60 mm diam) with the same malt agar medium as above were used for compatibility tests. Pairings were made by placing 2 × 4 mm mycelial mat pieces of each SBI pair 0.6 cm apart on the culture surface and mycelia were allowed to grow for 10 days. The character of the demarcation zone was evaluated and pieces of the agar with mycelial mat 5 mm on both sides of the demarcation line were transferred to 1.5 mL Eppendorf tubes containing 0.1 mL of Quiagen QX1 buffer to dissolve the agar. Small pieces of mycelium were added to water drops to check for clamp connections.

ITS amplification and sequencing

Sterile homokaryotic single-spore cultures G6 and S8 were isolated from plates after dissolving the agar in Quiagen QX1 buffer and washing with sterile water. Mycelia were frozen and disintegrated 60 s in mixer mill MM301 RETSCH under liquid nitrogen. DNA was isolated using CTAB/NaCl extraction buffer as described by Murray & Thompson (1980), followed by repeated extraction with chloroform and isopropanol precipitation. 18S rDNA (part), ITS1, 5.8S rDNA, ITS2 and 28S rDNA (part) were amplified according to White et al. (1990), using 55 °C annealing temperature with primers ITS1 and ITS4. Amplified DNA was purified using Wizard Clean Up kit PROMEGA and sequenced in the Genomics laboratory of Biology Centre, Academy of Sciences of the Czech Republic, České Budějovice, on ABI 3730xl DNA analyzer, using BigDye Terminator 3.1 kit. The sequence of the G6 isolate was deposited in GenBank (FJ788412).

Results

Antrodia serialiformis Kout & Vlasák, **sp. nov.** FIGURE 1

MYCOBANK MB512890; photos in (http://mykoweb.prf.jcu.cz/polypores)

Basidiocarpi perennes, effuso-reflexi vel resupinati, suberosi, 8–20 cm in diam., 0.5–1 cm crassi. Pilei rugosi, 0.5–2 cm lati, sed in serie confluenti, brunnei, margine acuto, albo. Pori albi, rotundati, 3–4 per mm. Systema hypharum dimiticum, hyphae generaticae tenuiter tunicatae, fibulatae, hyphae skeletales hyalinae, subsolidae, rectae, 3–5 µm in diam. Basidia clavata, 4-sterigmatica, 12–18 × 4–6 µm, basidiosporae hyalinae, laeves, IKI–, ellipsoideae vel subfusoideae, 4.5–5.5(6) × 2.0–2.3(2.5) µm. Cariem brunneam in ligno quercino producet.

Holotypus: Wissahickon Creek Park, Philadelphia, PA, USA, on oak log, 31. 8. 2008, leg. Josef Vlasák, herb. J. Vlasák JV0808/47. Isotypus in PRM 915459. Paratypus: French Creek St. Park, Hopewell, PA, USA, on oak log, 2. 8. 2001, leg. Josef Vlasák, JV0108/12b, in PRM 848583.

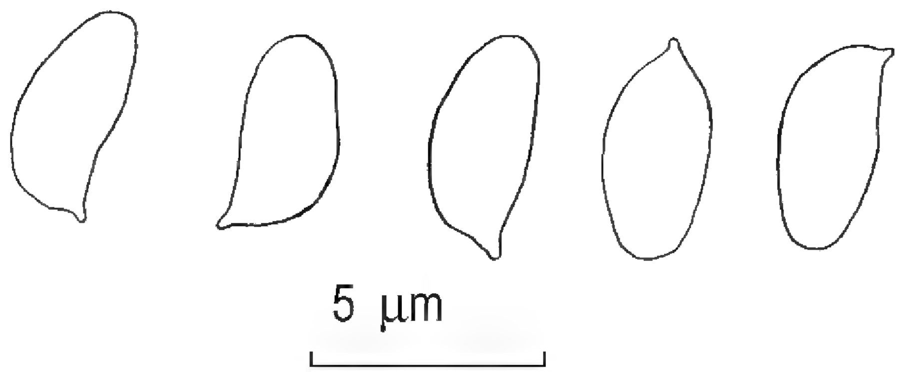

FIG. 1. *Antrodia serialiformis* (JV0809/47, holotype). Basidiospores.

Description

Basidiomes perennial, effused-reflexed, with small pilei in the upper part, often elongated along the substrata, up to 20 cm or more in length, very tough. Individual pilei up to 10 × 20 × 7 mm, with upper surface more or less horizontal, velutinate, uniformly brown, azonate or faintly zonate, margin white, narrow, sharp. Pore surface white, with age sordid brown, pores round, 3–4 per mm, tubes concolorous, up to 5 mm deep, context white, 1 mm thick.

Hyphal system dimitic, generative hyphae thin-walled, with clamp connections, 2–3 µm wide, skeletal hyphae dominating, hyaline, subsolid to thick-walled, straight, 2–5 µm wide. Cystidia absent, cystidioles inconspicuous. Basidia clavate, 4-sterigmatic, 12–18 × 4–6 µm with a basal clamp connection. Basidiospores ellipsoid to subfusiform, hyaline, negative in Melzer`s reagent, 4.5–5.5(6) × 2–2.3(2.5) µm, thin-walled.

REMARKS. *Antrodia serialiformis* is similar to *A. serialis,* but the latter has larger basidiospores (6.3–8 × 2.2–3.3 µm, Dai & Niemelä 2002). In addition, *A. serialiformis* grows on old decorticated trunk of *Quercus*, while *A. serialis* is usually on coniferous wood.

Mycelial cultures

Homokaryotic mycelia were isolated from three fertile *A. serialiformis* specimens collected from three localities in Pennsylvania, USA (TABLE 1). For comparison, homokaryotic mycelia were also prepared from two European *A. serialis* specimens collected near Boky, Hluboká n/Vlt., Czech Republic, on *Picea abies* logs (6.X.2007, collections JV0710/1&JV0710/2). Growth characteristics of mycelia from both species corresponded to descriptions of *A. serialis* mycelia published by Nobles (1943, 1965). Monosporic mycelia from *A. serialis* are perhaps more appressed to agar and thin ("sub-felty"), whereas those of *A. serialiformis* seemed more cottony. Variously shaped thick-walled chlamydospores were always noted for *A. serialiformis.* Mycelia from both species showed negative oxidase reactions with tetramethyl benzidine, pyrogallol, α-naphthol, pyrocatechol, tannic acid, *p*-cresol and tyrosine. Code

Symbols of *A. serialiformis* mycelia according to Nobles (1965) are 1.3.8.9.34.3 6.38.45.46.48.54.59.

Compatibility tests

Six to eight SBI from the 3 studied collections were checked for absence of clamps and then pairings were made in all possible combinations. In mating experiments, two types of contact zone morphology could be scored after 7–10 days of incubation. Compatible SBI developed a barrage zone in the young mycelia that was later more or less overgrown. Incompatible mycelia developed a sharply defined, congested contact zone. As expected, all 3 collections were determined as heterothallic with a monofactorial incompatibility system (bipolar). Still, in *A. serialiformis,* about 30% of monosporic mycelia in repeated pairing experiments produced few clamp connections in compatible pairings (scored based on contact zone morphology and abundant clamps in the pairing partner). Such mycelia were discarded.

Two compatible mating types were identified from each specimen and deposited in the culture collection. Six SBI of *A. serialiformis* from three localities were then paired in all combinations, with clamp connections formed in every pairing (results not shown) indicating that they contained different mating alleles (Raper et al. 1958). The same was true for pairings among *A. serialis* from the two European localities.

Pairings of *Antrodia serialiformis* with *Antrodia serialis*

Two compatible SBI from each of the *A. serialiformis* localities were paired in all combinations with two SBI from both European *A. serialis* specimens. Clamp connections were never formed and the contact zone morphology was consistent with incompatible pairing, indicating that *A. serialiformis* and *A. serialis* are different species.

ITS sequence analysis

Amplified sequence of 666 bp showed that only one base substitution in ITS1 discriminates between collections **G** and **S** (see Table 1) of *A. serialiformis.* The sequence blasted most significantly with five *A. serialis* ITS sequences deposited in the GenBank. In ITS1 (195b) there are 13–15 single bp substitutions or insertions/deletions (about 7% variable sites) between *A. serialiformis* and each of *A. serialis* and the same is true for ITS2 (196b). The sequence variability between each of *A. serialis* clones is only about 1.5% in ITS1 and 0.5% (one variable site) in ITS2. The second most similar ITS sequence of *A. variiformis* differs from *A. serialis* less than *A. serialiformis* (5–7 variable sites in ITS1 and about 12 in ITS2). This sequence comparison indicates that *A. serialiformis* is a distinct species related to *A. serialis.*

Discussion

During our first visit to Pennsylvania in 2001, we were surprised to find a widespread polypore very similar to *A. serialis* growing on old oak logs (Vlasák 2004). *Antrodia serialis* is very common in the Czech Republic, but there it rarely occurs on hardwoods and never on oaks (Kotlaba 1984). The same is true for the whole Europe (Ryvarden & Gilbertson 1993), perhaps with the exception of aspen as substrate in the northernmost Europe (Dai & Niemelä 2002). Moreover, we could find no *A. serialis* on conifers in lowland parts of Pennsylvania, Virginia, or Maryland, even in areas dominated by hemlock and pines woods or with occasional spruce stands. In the course of following visits in 2003, 2005, 2007 and 2008 we could only confirm the original observation and here we present experimental evidence demonstrating that the oak-growing polypore is a separate species, named here *A. serialiformis.*

Antrodia serialiformis shows some subtle macroscopic differences from *A. serialis*: it is more often pileate with more brownish and acute pilei. It never changes color to red as a result of hyphomycete infection. On the other hand, it is frequently eaten by microlepidoptera yielding powdery pore-surface, also characteristic for *A. serialis.* Despite the striking difference in the spore size (much smaller in *A. serialiformis*), unfortunately, many collections are completely sterile. We have inspected well developed, but sterile basidiocarps from three localities collected every 2–3 months from the same site over the whole year 2007, yet spores never appeared even when basidia with rudimentary sterigmata were detected in all collections from one locality.

Antrodia serialiformis, one of the most common polypore species in the eastern USA, grows abundantly in localities with lying oak logs. Sometimes it grows together with the grayish and strictly resupinate *A. oleracea* (R.W. Davidson & Lombard) Ryvarden, a species that is nonetheless far less frequently encountered.

Antrodia serialiformis undoubtedly has been previously misidentified as *A. serialis.* In the PACMA herbarium in Pennsylvania there are 19 collections of *Antrodia (Trametes) serialis* with identified substrates, 8 of which were collected on oak! We were unable to obtain these collections for direct comparison; however, given the sterility common in the species, it is probable that the collections lack spores needed for determination.

Taking into account the similarity of *Antrodia serialis* and *A. serialiformis,* the distribution in the eastern USA of true *A. serialis* is unclear. Gilbertson & Ryvarden (1986) cite *A. serialis* as present in all eastern states, including southern states, such as Florida, Louisiana, etc. Our experience suggests that *A. serialis* occurs south of New York only in the highest mountains of the Appalachians down to the Great Smoky Mountains, where it appears common on the highest peaks associated with fir and spruce. We suspect that lowland

'*A. serialis*' collections from the South are likely *A. serialiformis*. North of New York we did not find *A. serialiformis,* although *A. serialis* was locally abundant on spruce logs, especially in the White Mountains (NH) or Adirondack Park (NY). According to our experience, *A. serialiformis* does not occur on the western US coast where the *A. serialis* distribution is also unclear. Although Gilbertson & Ryvarden (1986) cite it as common in California, Oregon, and Washington, we were unable to find any specimen during extended visits in Sequoia, Kings Canyon, Yosemite, Redwoods, Olympic, and Mt. Rainier National Parks (Vlasák 2008).

Acknowledgements

We wish to express our thanks to Dr. Zdeněk Pouzar for important suggestions and help with the Latin diagnosis. Our thanks are also due to Josef Vlasák Jr., who provided fresh *Antrodia serialiformis* samples and revised the English language. We would like to thank Dr. Jan Holec and Dr. Yu-Cheng Dai for critically reviewing the manuscript.

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Leohumicola, a genus new to China

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Abstract —The anamorph genus *Leohumicola* is newly recorded from China. *Leohumicola verrucosa* was isolated from the root of a pharmaceutical plant, *Pleione yunnanensis* (*Orchidaceae*), collected in Guizhou Province. The morphology of this species is described and illustrated.

Key words — hyphomycetes, leotiomycetes

Introduction

The hyphomycetous genus *Leohumicola* was established by Hambleton et al. (2005) with four species (*L. verrucosa, L. minima, L. terminalis,* and *L. lenta*), with *L. verrucosa* as the type. Nguyen & Seifert (2008) added three new species (*L. levissima*, *L. atra* and *L. incrustata*) from South Africa and the United States and assessed the utility of both the ribosomal internal transcribed spacer (ITS) and cytochrome oxidase 1 (*Cox1*) as DNA barcodes for the identification of *Leohumicola* species. Species of the genus produce two-celled conidia, with a round to ellipsoidal, dark-brown, terminal cell that is either smooth or warty, and a basal cell that is either cupulate or cylindrical, and hyaline to pale brown. Most *Leohumicola* strains grow slowly on potato-dextrose agar (PDA) and tend to produce sterile colonies, often surrounded by yellow, green brown, or red pigments.

Several of the known species of *Leohumicola* are associated with burnt ecosystems, especially commercial blueberry cultivation, and were isolated by heat treatment of soil suspensions or from surface-sterilized roots of ericaceous host plants (Nguyen & Seifert 2008). Recently, we isolated and identified *L. verrucosa* in the course of surveys of endophytic fungi associated with a pharmaceutical plant in the family *Orchidaceae*. This fungal genus has not

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been reported in China previously. An illustrated description of the species is provided in the present paper based on our isolate from China.

Materials and methods

Healthy plants of *Pleione yunnanensis* Rolfe were collected from the Guizhou Province, China. The isolation of endophytic fungi was performed by the method described by Hu (2007). Colony and microscope descriptions are based on cultures grown on PDA at 25 °C under ambient light conditions in the laboratory. Measurements and microscopic photographs were taken from material mounted in 5 % KOH using a digital microscope camera on a ZEISS Axio Imager AI compound microscope with differential interference contrast (DIC) optics and captured using ImagePro Plus 6.0. The isolate was preserved as a living culture in the Center for Culture Collection of Pharmaceutical Microorganisms (CPCC, http://cpcc.org.cn/).

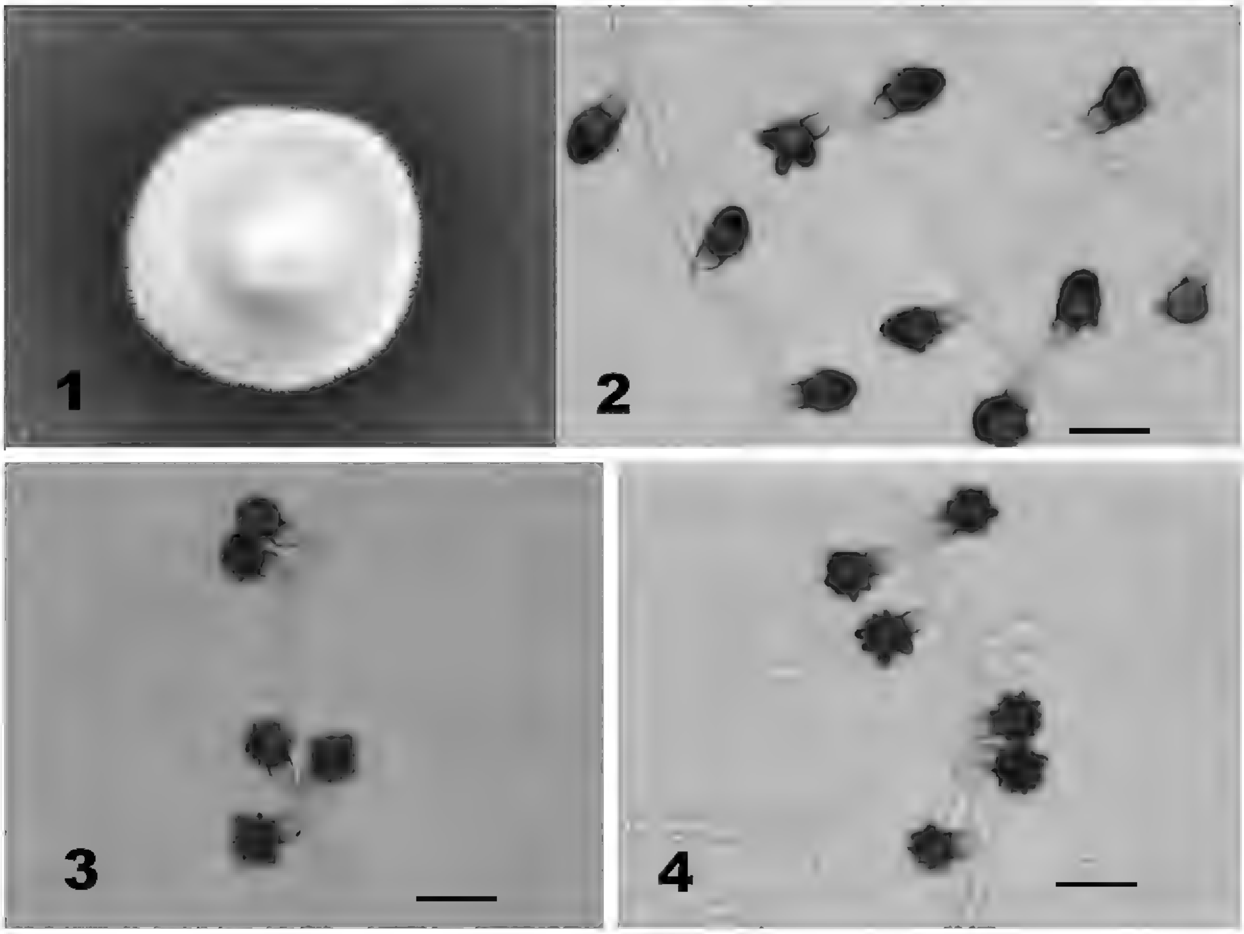
Taxonomy

Leohumicola verrucosa N.L. Nick., Hambl. & Seifert, Studies in Mycology 53: 44, 2005. Figs.1–4.

Colonies on PDA after 2 weeks under ambient light at room temperature (Fig.1) 10 mm diam, greyish green to olive yellow, or in the absence of yellow pigments, white to grey, with concentric rings, sometimes darkest near the inoculum, usually with more or less white margin, planar or convex, with low, felty, slightly lanose, or radiating funiculose aerial mycelium. Exudates not produced, pigment reddish brown. Margin smooth and entire. Colony reverse dark brown when soluble pigments are produced.

Conidiogenous hyphae hyaline, 1.5–2 µm wide. Conidiogenous cells reduced to a single denticle 1–3.5 µm long and 1–2 µm wide, the denticles single or the cell proliferating sympodially up to four times to produce a node or elongated cluster of divergent denticles (Fig.3).

Conidia (Figs.2–4) initially two-celled, single or side by side in small clusters, or with up to four successively produced sympodially from hyphae. Terminal cell 4.5–5.2(6.2) × 4–5 µm excluding the ornamentation, globose, subglobose to ovate, at first the same colour as the basal cell, then becoming dark brown while still attached, with walls slightly thickened, usually verrucose or echinulate; older conidia sometimes remaining smooth in some strains but more often with finger- or bubble-like projections or spines(Fig.2). Ornamentation 1–2 µm long, 0.7–2 µm wide at the base. Conidial connection to basal cell 2–3 µm wide, often constricted; basal cell 2.7–3.2 µm, cupulate, symmetrical or asymmetrical, subhyaline to pale brown; ratio of lengths of terminal: basal cell 1.4–2.1 µm.



Figs. 1–4. *Leohumicola verrucosa* (CPCC810187)
1. Colonies of *L. verrucosa* growing on PDA, after 14 d at room temperature;
2–4. Showing conidiogenous hyphae, conidia, and ornamentation of the terminal cell.
Scale bar =10 µm.

Chlamydospores sparsely produced. Vegetative mycelium often with swollen, hyaline or subhyaline hyphae 3–8 µm wide, constricted at septa, with slightly thickened walls.

Substrate and distribution: soil, roots; Canada, Puerto Rico, China.

Specimens examined: CHINA: GUIZHOU PROVINCE, Leigong County, Leigong Mountain, from root of *Pleione yunnanensis* Rolfe, 28 June 2007, Zhi-Xia Meng 3231(CPCC810187).

Remarks: The conidia of *L. verrucosa* are most similar to those of *L. incrustata* H.D.T. Nguyen & Seifert, but in the latter species, the walls are ornamented with larger, amorphous warts. Morphological features of the Chinese isolate are in agreement with the description by Hambleton et al. (2005), with a slight difference in colony morphology. The colony of the Chinese culture lacks the **conspicuous** sectoring in PDA that characterizes the original description. Our molecular analysis of the ITS nuclear rDNA region (FJ224102) supports the conspecificity of the Canadian and Chinese isolates (100% similarity GenBank sequence from *Leohumicola verrucosa*, AY706322).

Leohumicola verrucosa was originally described from Canada and Puerto Rico. Most isolates were from heated soil from coniferous forests and commercial low bush blueberry fields, or roots of *Ericaceae* and *Pinaceae*. In this paper, it was isolated from roots and pseudobulbs of *Pleione yunnanensis* (*Orchidaceae*) in China. Our collection considerably extends the host plant association and distribution for *L. verrucosa*.

Acknowledgment

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Polycauliona maheui, the basionym of *Rhizoplaca maheui* comb. nov.

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Abstract – The new combination and lectotypification of *Rhizoplaca maheui* is introduced for *Polycauliona maheui*. In addition, *Rhizoplaca bullata* is declared to be conspecific with *Rhizoplaca maheui* and is a heterotypic synonym of this last species.

Key words – lichens, *Lecanoraceae*, silicicolous

Introduction

Auguste-Marie Hue published, in "Notes relatives à la cryptogamie de l'Espagne. Les Lichens du Montserrat" (Maheu 1909), the diagnosis of a new species: *Polycauliona maheui*. Jacques Maheu signed the drawings included in the protologue (Fig 1A). The collector was Maurice Gillet, 1900, and the locality given is "Mines de Pont en Roya et Montserrat, Espagne" (Fig 1B).

Polycauliona maheui appears in Index Fungorum (2009) as basionym of *Caloplaca maheui*, and in Llimona & Hladun (2001: 456) under Nomina Inquirenda, with references for Spain cited by Maheu (1909) and Esteve (1932). Olivier (1921) also cited this species from Montserrat.

Follmann & Crespo (1976) published *Omphalodina bullata* as a new species and Leuckert & Poelt (1977) proposed a new combination as *Rhizoplaca bullata*. The diagnoses and type material of the two species show clearly that *Omphalodina bullata* and *Polycauliona maheui* are conspecific.

Material and methods

The morphology of the lichen specimens was examined using an Olympus SZ60 stereo microscope. Paraphyses, asci, ascospores and conidia were examined using a Zeiss Axioscope microscope. Chemical constituents were identified by thin-layer chromatography (Elix & Ernst–Russell 1993).

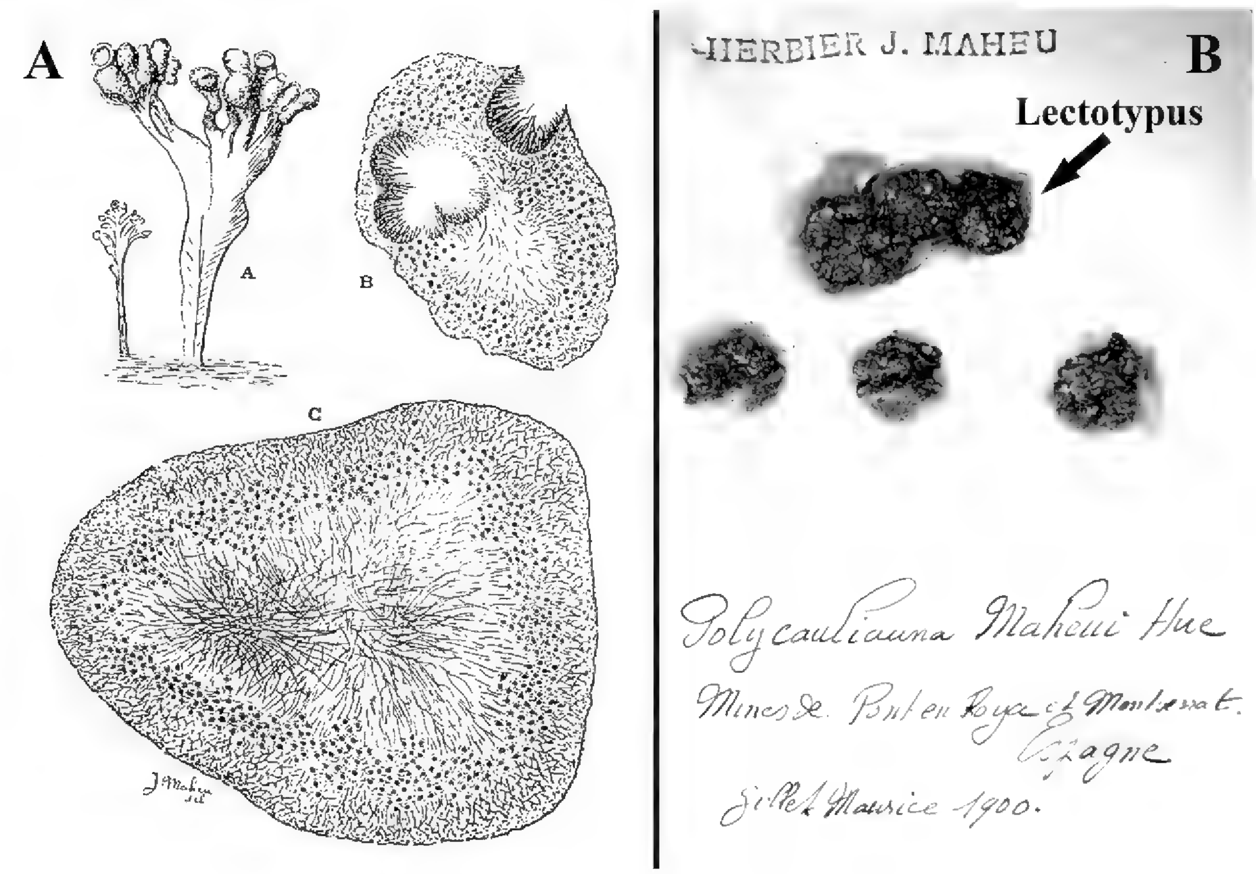

FIG 1. A. Drawings by J. Maheu accompanying the protologue.
B. Arrow indicates selected Lectotypus of *Rhizoplaca maheui* from the Herbarium Maheu (PC).

Taxonomy

We propose the new combination, *Rhizoplaca maheui*, lectotypified by material from Herbarium Maheu (PC).

Rhizoplaca maheui (Hue) Gómez-Bolea & M. Barbero, **comb. nov.** FIGS 1–3

MYCOBANK MB 513097

≡ *Polycauliona maheui* Hue, in Maheu, Bulletin de la Société Botanique de France 56: 390. 1909 (basionym). **Lectotypus (hic designatus)**: Espagne: Mines de Pont en Roya et Montserrat, 1900, leg. Maurice Gillet, Herbarium Maheu PC.

≡ *Caloplaca maheui* (Hue) Zahlbr., Cat. Lich. Univ. 7: 274. 1931.

= *Omphalodina bullata* Follmann & A. Crespo, Philippia 3(1): 24. 1976. ISOTYPUS: Spain: Zentralspanien, Prov. Toledo: koloniebildend an halbschattigen, luftfeuchten, teils überhängenden, verhältnismäßig glatten Silikatfelsen im *Leprarion chlorinae* Smarda et Hadac, 800 m, N, pH 6,5, Felstürme in der Sierra de Altamira unweit Puerto de San Vicente. Leg. et det. G. Follmann et A. Crespo, 1975 (BCC–Lich. 1200).

≡ *Rhizoplaca bullata* (Follmann & A. Crespo) Leuckert & Poelt, Bibliotheca Lichenologica 9: 233. 1977.

Description of the lectotype FIGS 2, 3

THALLUS fruticose, pulvinate, ochre-yellowish-green colour when stored for long time in the herbarium, in some zones with crystalline grains giving it a

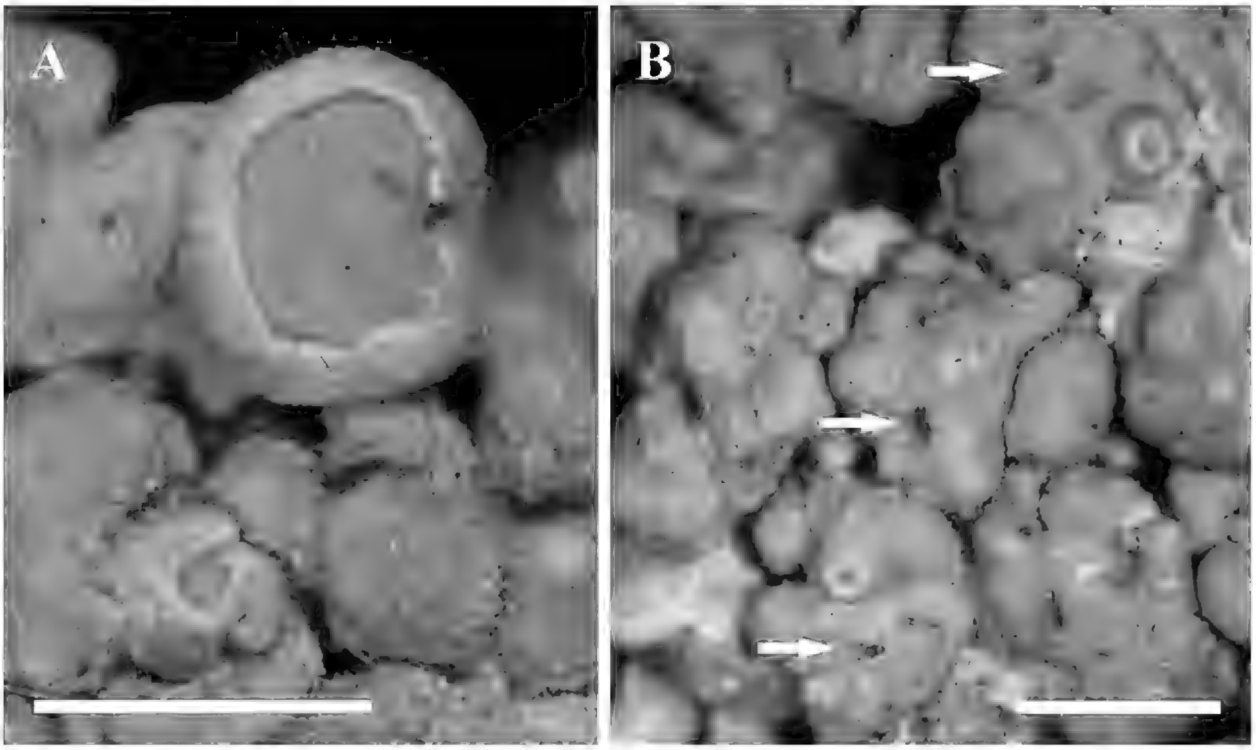

FIG 2. *Rhizoplaca maheui* (lectotypus, Herb. Maheu, PC).
A. Detail of apothecium. B. Detail showing pycnidia (arrows).
Scale bar: A = 1.5 mm; B = 1 mm.

white pruinose aspect, 10–15 mm diam. and 6 mm tall. Basal part of blackish-brown colour, laciniae up to 3·5 mm wide, with bullate tips c. 7.5 mm diam. APOTHECIA lecanorine, up to 1.6 mm diam., with a distinct thalline margin 0.1–0.2 mm wide, with an urceolate then flat to ± undulating and ochre-yellowish-green disc, concolorous with thalline margin, in some cases with the same crystalline grains as the thallus. HYMENIUM colourless to pale brown, 62–70 µm high, I+ blue. EPIHYMENIUM brown, containing abundant minute crystals that dissolve in K, 7–10 µm thick. HYPOTHECIUM pale brown, containing abundant minute crystals that dissolve in K, c. 25 µm thick. PARAPHYSES conglutinated, branched, septate, occasionally anastomosing, 2.3–2.5 µm wide, with apical cells not or slightly capitate (3.2 µm). *Asci* clavate, 8-spored, 50–55 × 16 µm, of *Lecanora*-type (Purvis et al. 1992: 661). ASCOSPORES colourless, simple, ellipsoidal, 8–14 × 4–6 µm.

PYCNIDIA immersed, urceolate, concolorous with the thallus; ostiolum 80–160 µm diam. CONIDIA filiform, 21–27 × 0.8 µm.

CHEMISTRY. Cortex K–, KC+ yellowish, P–; medulla K± red brown, KC–, P+ red; containing usnic and fumarprotocetraric acids (major), protocetraric and confumarprotocetraric acids (minor).

SPECIMENS EXAMINED: *Polycauliona maheui*: Maurice Gillet collection, Herbarium Maheu, PC.

Omphalodina bullata: Isotypus BCC-Lich. 1200.

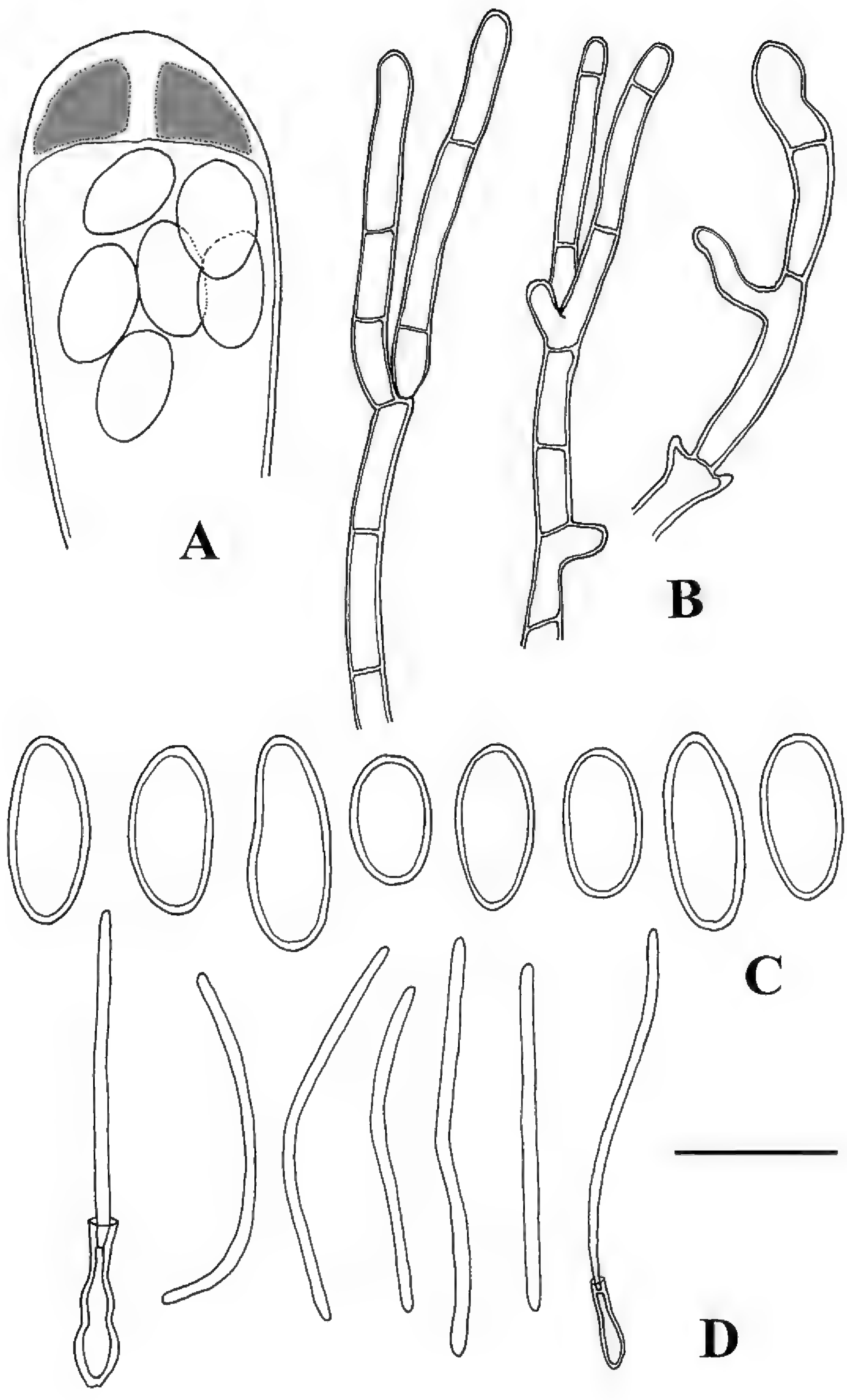

Fig. 3. *Rhizoplaca maheui* (lectotypus, Herb. Maheu, PC).
A. Ascus structure (in I, after pre-treatment with KOH). B. Paraphyses.
C. Ascospores. D. Conidia and conidiogenous cells.
Scale bar = 10 μm.

TABLE 1. Type material of *Polycauliona maheui*. Discordance between Maheu's description and our observations.

	MAHEU 1909	CURRENT OBSERVATIONS
THALLUS	5–12 mm high	≤ 6 mm high
APOTHECIA	1–5 mm diam.	0·6–1.6 mm diam.
PARAPHYSES	3–4 µm diam.	Conglutinated, branched, septate, occasionally anastomosing, 2.3–2.5 µm diam.
ASCI	50 × 12.5 µm	50–55 × 16 µm
ASCOSPORES	8–11 × 44.5 µm	8–14 × 4–6 µm
PYCNIDIA	Ostiolum 120–180 µm diam.	Ostiolum 80–160 µm diam.
CONIDIA	20–28 × 0.5–0.6 µm	21–27 × 0.8 µm

COMMENTS: Our description shows certain discordances with the protologue (Maheu 1909), which are summarized in TABLE 1. The differences between our observations of the isotypus of *Omphalodina bullata* (BCC-Lich. 1200) and Follmann & Crespo's description (Follmann & Crespo 1976) are summarized in TABLE 2.

TABLE 2. Isotypic material of *Omphalodina bullata*. Discordance between Follmann & Crespo's description and our observations.

	FOLLMANN & CRESPO 1976	CURRENT OBSERVATIONS
LACINIAE	1–2 mm wide	≤ 3.5 mm wide
APOTHECIA	2–4(–5) mm diam.	≤ 2.75 mm diam.
PARAPHYSES	Simple, aseptate, apical cells non-capitate	Branched, septate, 2.2–2.5 µm wide, apical cells sometimes slightly capitate, ≤ 3.2 µm
ASCOSPORES	Subglobose to ellipsoidal, 7–10 µm diam.	Ellipsoidal 10–12 × 5–6 µm
CONIDIA	4–6 × 1 µm	21–27(–30) × 0.8 µm
CHEMISTRY	Usnic, fumarprotocetraric, & protocetraric acids	Major — usnic & fumarprotocetraric acids Minor— protocetraric & confumarprotocetraric acids

The lectotype label data present a problem, because two localities are indicated on the label: "Mines de Pont en Roya" and "Montserrat" but only one country (Spain) (FIG 1B). We do not know any location in Spain with the name "Mines de Pont en Roya", but it is possible that the author refers to a locality in France across the river Roya in the Mercantour massif on the Maritime Alps. Regarding the reference "Montserrat", and after a number of visits to this well-known Catalan mountain, we have not been able to find this species again. As we could not locate Esteve's herbarium, we cannot confirm Esteve's citation of (1932) of Montserrat.

Acknowledgements

We thank the Curator of PC for the loan of a specimen and Javier Etayo and Claude Roux for presubmission reviews. The authors also acknowledge financial support from the projects B0S2001-0869-C04-02 (Spanish Government) and 2000SGR00036 (Catalan Government).

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A new species of *Melanohalea* (*Parmeliaceae*) from the Tibetan Plateau

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Abstract —A new *Melanohalea* species characterized by the lobules developed from hemispherical papillae, *M. lobulata*, is described from the Tibetan Plateau. A key to the twenty known *Melanohalea* species is also provided.

Keywords — Asia, China, lichen, taxonomy

Introduction

The lichen genus *Melanohalea* O. Blanco et al. in the *Parmeliaceae* was segregated from *Melanelia* Essl. based on molecular as well as chemical and morphological data (Blanco et al. 2004). The genus is morphologically characterized by an upper surface usually with pseudocyphellae, by a non-pored epicortex, and by a medulla containing depsidones or lacking secondary compounds (Blanco et al. 2004, Esslinger 1977). The genus presently includes nineteen species known in the world (Esslinger 1977, Esslinger 1987, Galloway & Jørgensen, 1990, Divakar et al. 2001, Blanco et al. 2004, Divakar & Upreti 2005, Wang et al. 2008).

During our study of the lichen flora of the Tibetan Plateau, an interesting species of *Melanohalea* that appears to be new to science was found. Here we present a brief Latin diagnosis, an extended description, and a key to the presently known species of the genus. Two photographs of the new species are provided as well.

Materials and methods

The specimens studied were collected from the Tibetan Plateau, China, and are preserved in SDNU (Lichen Section of Botanical Herbarium, Shandong

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Normal University). The morphology of the lichen specimens was examined using a stereo microscope (COIC XTL7045B2) and a microscope (OLYMPUS CX21). Lichen substances in all specimens cited were identified using the standardized thin layer chromatography techniques (Culberson 1972). Photos of the thallus were taken under OLYMPUS SZX12 with DP70.

Key to *Melanohalea* species

1a. Thallus with soredia or isidia 2
1b. Thallus without soredia or isidia, sometimes with lobules......................11

2a. Thallus with soredia 3
2b. Thallus with isidia 6

3a. Upper surface without pseudocyphellae; soralia laminal, punctiform; soredia granular to isidioid; medulla usually PD+ red-orange, with fumarprotocetraric acid and protocetraric acid ....*M. olivaceoides*
3b. Upper surface with pseudocyphellae 4

4a. Medulla PD+ red-orange, with fumarprotocetraric acid and protocetraric acid; soredia granular to isidioid, developed from pseudocyphellae ....*M. gomukhensis*
4b. Medulla PD–, with caperatic acid or lacking substances;......................5

5a. Caperatic acid present; soralia capitate, laminal; soredia granular, pale *M. nilgirica*
5b. No substances detected; soralia punctiform, developed from pseudocyphellae; soredia coarse-grained, rather dark ....*M. inactiva*

6a. Medulla PD+red-orange, with fumarprotocetraric acid; isidia cylindrical, dense; corticolous .... *M. poeltii*
6b. Medulla PD–, without substances 7

7a. Isidia clavate to spathulate, distinctly hollow, developed from hemispherical to spherical papillae; usually corticolous ....*M. exasperatula*
7b. Isidia cylindrical or granular, not distinctly hollow 8

8a. Isidia developed from conical papillae with pseudocyphellae at the tips, cylindrical, usually branched ....*M. elegantula*
8b. Without pseudocyphellae at the tips of papillae or isidia 9

9a. Isidia developed from hemispherical papillae, cylindrical, growing into lobules usually with rhizines ....*M. subelegantula*
9b. Isidia seldom growing into lobules 10

10a. Saxicolous, living in the Northern hemisphere; isidia developed from hemispherical papillae, cylindrical, sometimes hollow; upper surface without pseudocyphellae; apothecia unknown ....*M. infumata*
10b. Corticolous usually, living in the Southern hemisphere; isidia developed from granular papillae, cylindrical, occasionally growing into lobules; upper surface sometimes with pseudocyphellae; apothecia common ....*M. ushuaiensis*

11a. Medulla PD+ red-orange, with fumarprotocetraric acid and protocetraric acid 12
11b. Medulla PD–or PD+ yellow, with or without norstictic acid 14

12a. Apothecia margin smooth; hymenium twice as thick as subhymenium; pseudocyphellae sparse or absent . . . . *M. septentrionalis*
12b. Apothecia margin crenulate or warted; hymenium as thick as subhymenium; pseudocyphellae numerous 13

13a. Upper surface brown, rarely papillate; medulla K–; spores smaller, 11–16 × 6–9 µm . . . . *M. olivacea*
13b. Upper surface yellow-brown, frequently papillate; medulla K+yellow turning dingy orange; spores larger 15–20 × 8–12.5 µm . . . .*M. halei*

14a. More than eight spores per ascus (12–32) 15
14b. Eight spores per ascus or apothecia absent 16

15a. Medulla K– to K+, yellow turning orange, with or without norstictic acid; lower surface smooth to weakly trabeculate . . . . *M. multispora*
15b. Medulla K–, no substances detected; lower surface strongly trabeculate . . . . *M. trabeculata*

16a. Upper surface with numerous lobules or lobe-like folioles developed from papillae 17
16b. Upper surface without lobules or lobe-like folioles developed from papillae 18

17a. Papillae isidioid, with obscure pseudocyphellae at the tips; the papillae often expanding to lobe-like and laciniate folioles . . . . *M. laciniatula*
17b. Papillae hemispherical, without pseudocyphellae at the tips; the papillae soon becoming elongated-ellipsoid lobules . . . .*M. lobulata*

18a. Upper surface with evenly distributed and regular papillae; the papillae conical or isidioid, with obvious pseudocyphellae at the tips . . . .*M. exasperata*
18b. Upper surface without evenly distributed and regular papillae 19

19a. Apothecial margin with pseudocyphellae at the tips of warts or tubercles; upper surface sometimes with unevenly distributed and irregular papillae; living in Northern hemisphere . . . . *M. subolivacea*
19b. Apothecial margin with pseudocyphellae, the warts or tubercles absent; upper surface without papillae; living in Southern hemisphere . . . . . *M. zopheroa*

Taxonomic description

Melanohalea lobulata F.G. Meng & H.Y. Wang, **sp. nov.** Fig. 1

MycoBank MB 513104

Species lobulis elongato-ellipsoideis ex papillis a congeneribus diversa.

Typus: CHINA. Sichuan, Litang, Kazilashan, alt. 4710m, on twigs, H.Y. Wang, 20084049, 7 November 2008. (**holotypus** in SDNU).

Description: Thallus foliose, appressed throughout, adnate, 2–13 cm in diameter (Fig. 1A). Lobes 0.8–2 mm broad, 100–125 µm thick, flat, short, contiguous to imbricate. Upper surface dark-brown, shiny at lobe ends, inward

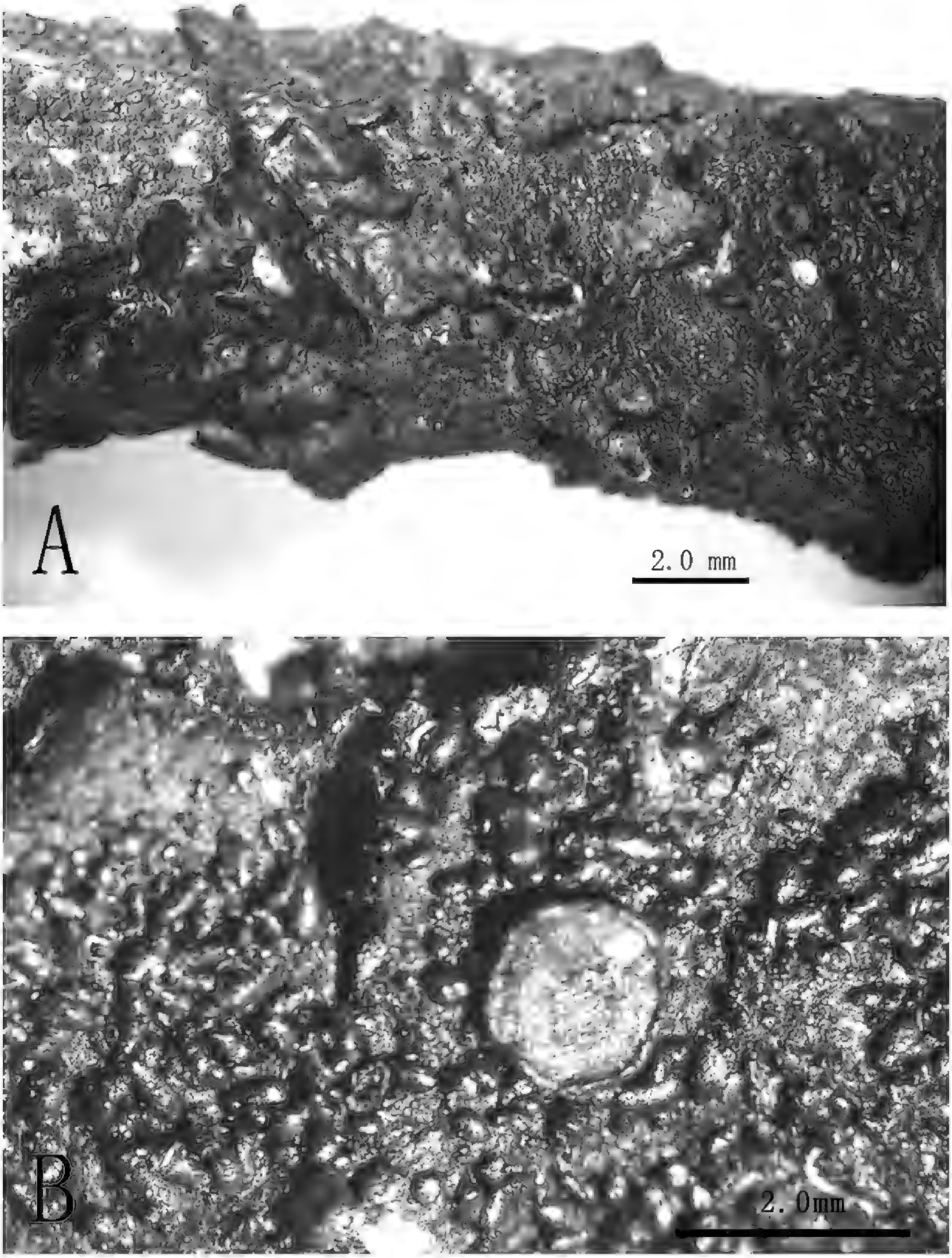

Figure 1 Photographs of the holotype of *Melanohalea lobulata*.
A. Thallus. B. Lobules and apothecium.

becoming dull; without pseudocyphellae, soredia, isidia or pruina; with numerous lobules developed from papillae, the lobules elongated-ellipsoid, simple, 0.5–0.2 × 0.1–0.3 mm, appressed to thallus, with shiny upper surface and with rhizines under their lower surface (Fig. 1B); the papillae hemispherical,

very small, soon expanding into lobules, never elongating into isidia. Lower surface black, often paler at the margin; smooth to wrinkled, dull to slightly shiny; abundantly rhizinate, the rhizines simple, concolorous with the lower surface, to 1 mm long. Apothecia common, sessile, flattening, to 2 mm in diameter; margin entire, smooth; hymenium ca. 50 μm thick; subhymenium ca. 40 μm thick; spores 8, ellipsoid to broadly ovoid, 10–12.5 × 5–7.5 μm, spore wall 1 μm thick. Pycnidia unknown.

Chemistry: Cortex K–, HNO_3–; medulla C–, K–, KC–, PD–; Constituents (31 specimens tested): no substances detected.

Distribution and substrate: At present, *M. lobulata* is known only from the type locality; on twigs.

Specimens examined: **CHINA. SICHUAN: Litang Co.** kazilashan, alt. 4710m, on twigs 7/xi/2008, *H. Y. Wang 20084035, 20084037, 20084038, 20084039, 20084040, 20084042, 20084047, 20084048, 20084049, 20084050, 20084051, 20084052, 20084053, 20084054, 20084055, 20084056, 20084057, 20084103, 20084104, 20084105, 20084106, 20084107, 20084108, 20084109, 20084110, 20084111, 2008112, 20084113, 20084114, 20084115, 20084116* (SDNU).

Comments —The elongated-ellipsoid lobules developed from papillae distinguish *M. lobulata* from all the other *Melanohalea* species. In addition to *M. lobulata*, *M. subelegantula* (Essl.) O. Blanco et al. also has lobules on upper surface. *Melanohalea lobulata* can be clearly separated from *M. subelegantula,* however, by lacking isidia, and by having simple rather than branched lobules, a darker upper surface, common rather than rare apothecia, and entire rather than papillae-crenulate apothecial margins. *Melanohalea laciniatula* (Flagey ex H. Olivier) O. Blanco et al. has lobe-like folioles on the upper surface, but does not have true lobules. *Melanohalea lobulata* can be readily distinguished from *M. laciniatula* by the hemispherical rather than isidioid papillae, and by lacking pseudocyphellae at the tips of the papillae.

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Lepraria glaucosorediata sp. nov. (*Stereocaulacae*, lichenized *Ascomycota*) and other interesting records of *Lepraria*

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Abstract — *Lepraria glaucosorediata* is described as new to science from Bolivia. It is characterized by a thick, stratified thallus with external, farinose soredia bearing bluish gray pigment and by the presence of alectorialic, lecanoric, and protocetraric acids. *L. zeorinica* stat. et comb. nov. is raised to the species level and reported for the first time for Europe (France). *L. coriensis* is reported as new to Yemen, *L. impossibilis* as new to Costa Rica, *L. lobificans* as new to Jamaica and Vietnam, *L. pallida* as new to Asia (North Korea), *L. vouauxii* as new to Jamaica and *L. yunnaniana* as new to Bolivia.

Key words — chemotaxonomy, neglected habitats, new species, sterile lichens

Introduction

Lepraria Ach. is a cosmopolitan lichen genus comprising currently ca 60 species. However, investigations in poorly known regions continue to reveal new species, and extensions of the known distribution range of many taxa are being recorded continuously. The tropics remain among the least studied regions and it is very likely that more new species of *Lepraria* will be described from its ecosystems, the world's biologically richest (see Flakus & Kukwa 2007 and literature cited therein, Saag et al. 2009).

This paper presents new information on the distribution and taxonomy of *Lepraria*, mainly from tropical regions. One species is described as new to science from the Bolivian high Andes and one is raised to species level. Additionally, several new records are provided from Asia (Yemen, North Korea, Vietnam), Europe (France), South America (Bolivia), and Central America (Costa Rica, Jamaica).

Material and methods

This study is based on collections deposited in B, BR, DUKE, KRAM, LPB, S, UGDA and the private herbaria of P. Diederich and A. Flakus. Morphology was studied using a stereomicroscope. Anatomy was examined by compound microscope on squash preparations mounded in water or KOH solution, with or without pre-treatment with acetone. Chemical analyses were carried out by thin layer chromatography (TLC) in solvent systems A, B and C according to the methods of Orange et al. (2001a). When the secondary metabolite was always present it is marked with (+); when the substance was absent from a proportion of the specimens (±) is used.

The taxa

Lepraria coriensis (Hue) Sipman, Herzogia 17: 28. 2004.

≡ *Crocynia coriensis* Hue, Bull. Soc. Bot. France 71: 386. 1924.

≡ *Lecanora coriensis* (Hue) J.R. Laundon, Nova Hedwigia 76: 97. 2003.

Morphology: This species develops a greenish to yellowish grey thallus, often forming irregular rosettes with farinose granules on the surface. The edge of the thallus has small, regular lobes with usually raised, or rarely flat margin (see also Laundon 2003, Sipman 2004, Elix 2006).

Chemistry: Usnic acid (+) and zeorin (+) were detected as major secondary compounds. Also Laundon (2003) and Sipman (2004) reported these lichen substances. More detailed chemistry was presented by Elix (2006). The thallus does not react with C, K or P.

Ecology — *Lepraria coriensis* may grow on soil, rocks, tree bark or mosses (Laundon 2003, Sipman 2004, Elix 2006). The specimen reported here was found on a tree branch.

Distribution — So far the species has been reported from South Korea, India, China and Australia (Laundon 2003, Sipman 2004, Elix 2006). Here it is reported as new to Yemen.

Comments — *Lepraria coriensis* is characterized by the presence of rounded lobes and the production of usnic acid and zeorin. Only *L. usnica* Sipman produces the same secondary metabolites in combination with lobes. However, in the latter the lobes are squamulose and smaller (rarely up to 0.2 mm wide), somewhat irregular (not rounded as in *L. coriensis*), and lack a marginal rim (Sipman 2004, Elix 2006). *Lepraria usnica* differs also chemically, because it produces additionally contortin in minor amounts, a rare metabolite absent in *L. coriensis* (Elix 2006). Also *L. ecorticata* (J.R. Laundon) Kukwa, *L. leuckertiana* (Zedda) L. Saag (syn. *Lecanora leuckertiana* Zedda), *L. straminea* Vain. and *L. texta* K. Knudsen et al. produce usnic acid and zeorin, but those species

never develop regular and rounded lobes (Zedda 2000, Kukwa 2006a, Flakus & Kukwa 2007, Knudsen & Elix 2007, Saag et al. 2009).

Recently the phylogenetic position of *Lepraria coriensis* was studied, and it does not belong to *Lepraria* s.str., but its phylogenetic position remains unclear (Nelsen et al. 2008). As the species is morphologically very similar to other species of *Lepraria*, it is still included in this paper.

Specimen examined—**YEMEN. Gov. Al. Mahra**, coastal mountains between Al. Faydami and Hawf, N of Jadib, steep slopes with boulders directly below the J. Chatan escarpment, alt. 850–920 m, 16°34'N, 52°48'E, dense semideciduous woodland, on branch—13.10.2000, P. Hein 8131b (B).

Lepraria glaucosorediata Flakus & Kukwa, **sp. nov.** PLATE 1

MycoBank MB 512680

= *Lepraria* sp. 1 sensu Flakus & Kukwa, Lichenologist 39: 471. 2007.

Thallus crustaceus, leprosus, stratosus, effusus, virido-griseus usque ad glauco-griseus; medulla discreta, alba; soredia externa farinosa, ex hyphis cum pigmento glauco-griseo vel hyphis hyalinis, sine hyphis filamentosis projectis; acida alectoricum, lecanoricum et protocetraricum continens.

Typus: Bolivia. East Cordillera, Dept. La Paz, Prov. Murillo, near Cumbre pass, 16°21'59"S, 68°02'37"W, alt. 4604 m, on siliceous schist and saxicolous bryophytes, 13.05.2006, A. Flakus 5785 (KRAM-L–**holotypus**, LPB–isotypus).

Etymology: The epithet refers to the distinctly bluish external soredia.

Description: Thallus crustose, episubstratal, thick, leprose, with well delimited border, but non-lobate, green grey to bluish grey, sometimes white in areas with exposed medullary layer; true medulla absent, but a thick layer of whitened and compacted soredia resembling medulla present; hypothallus not well differentiated, thin, of white or brownish hyphae; soredia farinose, rounded, up to ca. 30 μm in diam., of two types, one with single large algal cell (up to 10–17 μm in diam.), the second with several smaller algal cells (ca. 5 μm in diam.), external soredia of both types hyaline or with bluish-grey pigment; consoredia rarely developed, up to 100 μm in diam.; soredial wall very well developed, complete, up to ca 5 μm thick, of 1–4 cell layers, hyaline or partly to entirely pigmented, projecting hyphae not observed; pigment situated in fungal cells, C+ orange to orange brown, K+ olivaceous brown; photobiont chlorococcoid, with rounded, green cells up to 10–17 μm in diam.

Chemistry: Alectorialic (+), lecanoric (+), and protocetraric (+) acids. The chemistry was checked in 5 different places of the specimen to avoid possible contaminants of other superficially similar taxa, and the chemistry appeared to be constant. Thallus C+ carmine red, P+ orange, in most parts K+ yellow.

Ecology — The species was found on rock and saxicolous mosses in a humid and shaded place in high Andean puna.

Distribution — So far it is known only from the type locality in Bolivia.

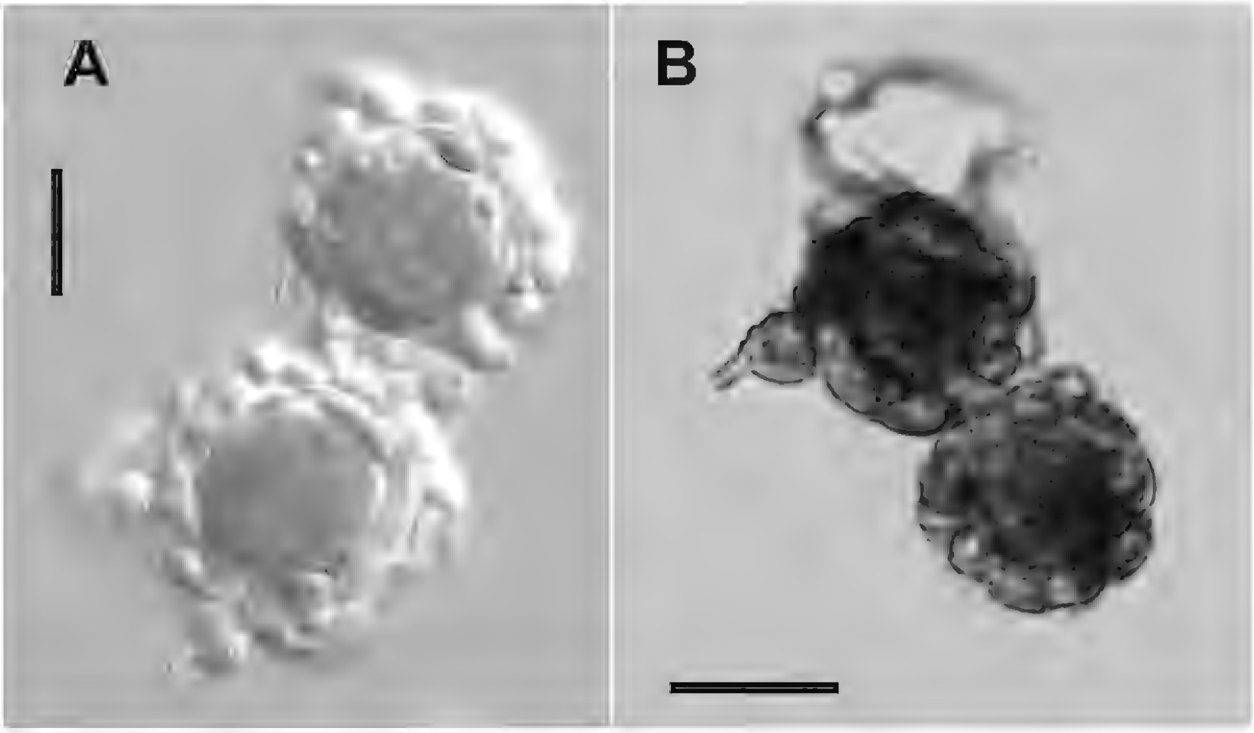

PLATE 1. Soredia of *Lepraria glaucosorediata*, with unpigmented (A) and pigmented soredial walls (from the holotype; scale 10 µm for A & B).

COMMENTS — *Lepraria glaucosorediata* has been already recognized as a distinct taxon by Flakus & Kukwa (2007), who hesitated to describe it formally. Recently we re-examined the collection and found some diagnostic morphological characters not observed before: soredia with thick soredial wall, absence of projecting hyphae on the soredia, presence of a bluish grey pigment in external soredia, and two types of soredia, one with several algal cells, the other with a single large algal cell. The combination of the unusual chemistry and morphology makes the species unique in the genus, and therefore, we have decided to described it here as new to science.

Chemically the species is similar to *L. achariana* Flakus & Kukwa, in the presence of lecanoric acid, and to *L. eburnea* J.R. Laundon in the presence of alectorialic and protocetraric acids (Laundon 1992, Tønsberg 1992, Orange 1997, Flakus & Kukwa 2007). However, both lack a bluish pigment in the soredial wall, their soredial wall and thallus are thinner, and, as far it is known, they do not produce soredia with one large algal cell as in *L. glaucosorediata*. Additionally, the soredial wall in *L. eburnea* is usually incomplete (Tønsberg 1992, Flakus & Kukwa 2007, Kukwa unpubl.). Morphologically *L. glaucosorediata* resembles *L. incana* (L.) Ach. The latter often has a similar thick thallus and many specimens have the same bluish pigment in the soredia. The taxa can be separated predominantly by the chemistry, as *L. glaucosorediata* produces alectorialic, lecanoric and protocetraric acids, whereas *L. incana* has divaricatic acid and zeorin (Tønsberg 1992, Flakus & Kukwa 2007). Additionally, we have never observed two distinct types of soredia in *L. incana* so far.

Lepraria impossibilis Sipman, Herzogia 17: 30. 2004.

Morphology: This species is rather variable in thallus colour. It is greenish grey to grey-brown with an orange tinge. It is leprose or may develop more or less thick and stratified, irregular rosettes with diffuse or obscurely lobed margin. It is morphologically very similar to *L. vouauxii* (e.g. Sipman 2004, Flakus & Kukwa 2007).

Chemistry: Lecanoric acid (+), pannaric acid-6-methylester (+), 4-oxypannaric acid-6-methylester and traces of additional dibenzofurans were detected in the specimen from Costa Rica. Flakus & Kukwa (2007) reported also 'vouauxii unknown 1' and traces of unidentified anthraquinones as uncommon accessory substances. The thallus reacts C+ red.

Ecology — *Lepraria impossibilis* was reported on soil, rocks, tree bark or mosses (Sipman 2004, Flakus & Kukwa 2007). The Costa Rican specimen was found on tree bark.

Distribution — So far the species has been reported from one locality in El Salvador in Central America (Sipman 2004), Bolivia, Chile and Peru in South America (Flakus & Kukwa 2007) and one locality in Asia (Iran) (Kukwa & Sohrabi 2008). Here it is reported as new to Costa Rica. It is the second record from Central America.

Comments — The production of lecanoric acid, pannaric acid-6-methylester and the diffuse or obscurely lobed thallus are the distinguishing characters of *Lepraria impossibilis*. Only *L. vouauxii* is chemically and morphologically similar, however it produces only dibenzofurans with pannaric acid-6-methylester as a major secondary metabolite and lacks lecanoric acid. The only other species containing pannaric acid-6-methylester is *L. sipmaniana* (Kümmerl. & Leuckert) Kukwa, but that taxon develops regular lobes with raised rim and does not contain lecanoric acid (Leuckert & Kümmerling 1991, Sipman 2004, Flakus & Kukwa 2007). In the presence of lecanoric acid, *L. impossibilis* is similar to *L. achariana*, *L. cupressicola* (Hue) J.R. Laundon (syn. *L. atrotomentosa* Orange & Wolseley), *L. goughensis* Elix & Øvstedal and *L. lecanorica* Tønsberg. Predominantly they differ in chemistry, as none of them has substances related to pannaric acid-6-methylester (Orange et al. 2001, Sipman 2004, Tønsberg 2004, Elix et al. 2005, Flakus & Kukwa 2007).

Specimen examined—**COSTA RICA. Cartago Prov.** 10 km NE of Cartago, 4 km N of Cot, 09°56'N, 83°52'W, 2500 m, on bark—07.01.1979, R. Santesson 28820 (S–F53695).

Lepraria lobificans Nyl., Flora 56: 196. 1873.

Morphology: *Lepraria lobificans* has an obscurely lobed, woolly thallus with well developed medullary layer. Its soredia with incomplete wall are often

grouped in consoredia, and bear usually long and well visible projecting hyphae (Tønsberg 1992, Sipman 2004, Flakus & Kukwa 2007).

Chemistry: Atranorin (+), stictic acid complex (+), and zeorin (+), sometimes with possible traces of unidentified terpenoids (±) or fatty acids (±) were detected in the studied specimens. Notes on the chemistry are presented by Tønsberg (1992), Leuckert et al. (1995), Sipman (2004), and Flakus & Kukwa (2007). Thallus C–, KC–, K– or + yellow and P+ orange.

Ecology — *Lepraria lobificans* has a very wide ecological amplitude, but seems to prefer humid places (e.g. Tønsberg 1992, Sipman 2004, Kukwa 2006b, Flakus & Kukwa 2007). It may grow on a very wide range of substrates. The here presented specimens were collected from rock and mosses.

Distribution — The species is very widely distributed, cosmopolitan, very common at least in some areas. It is known from all continents except Antarctica (e.g. Laundon 1992, Kümmerling et al. 1993, Sipman 2004, Flakus & Kukwa 2007). Here it is reported for the first time from Jamaica and Vietnam.

Comments — *Lepraria lobificans* is characterized by a thick, stratified and usually woolly thallus and the presence of atranorin, zeorin, and the stictic acid complex. The species is chemically similar to *L. elobata* Tønsberg, *L. leprolomopsis* Diederich & Sérus., *L. multiacida* Aptroot and *L. santosii* Argüello & A. Crespo by the production of atranorin and the stictic acid complex (Tønsberg 1992, Aptroot et al. 1997, Aptroot 2002). However, all these species are morphologically or chemically easily distinguished from *L. lobificans*: *L. elobata* has a thallus with diffuse margin and soredia with well developed, complete wall lacking projecting hyphae, *L. leprolomopsis* produces an unidentified terpenoid instead of zeorin, *L. multiacida* contains additionally salazinic and consalazinic acids and *L. santosii* develops lobate margin with slightly raised rim (Tønsberg 1992, Aptroot et al. 1997, Aptroot 2002, Crespo et al. 2006, Flakus & Kukwa 2007).

Specimens examined—**JAMAICA. Blue Mountain District.** Portland, just beyond Hardwar Gap, underhand of the rock by stream beside road, on rock— 17–27.12.1968, W.L. Culberson 13914, C.F. Culberson (DUKE). **VIETNAM. Son La Prov. Moc Chau District**. Van Ho Municipality, off Hwy 6 at 180 km mark SE of Moc Chou, 1225 m, 20°46'30"N/104°47'74"E, on moss—06.10.2000, D.E. Stone (DUKE).

Lepraria pallida Sipman, Herzogia 17: 33. 2004.

Morphology: *Lepraria pallida* has a rather thick thallus consisting of whitish grey soredia produced on a black hypothallus. The thallus margin is more or less diffuse or obscurely lobed (see also Sipman 2004 and Flakus & Kukwa 2007).

Chemistry: Atranorin (+), zeorin (+), and an unidentified fatty acid (+) were detected. For information on the chemistry see also Sipman (2004) and Flakus & Kukwa (2007). The thallus does not react with C, K or P.

Ecology — The species was reported from rock, humus, tree bark, and soil (Sipman 2004, Flakus & Kukwa 2007). The two specimens reported here were collected on a granite block and on soil.

Distribution — So far *Lepraria pallida* has been reported from Bolivia (Flakus & Kukwa 2007), Brazil, Madagascar, and the Seychelles (Sipman 2004). Here it is reported from Asia (North Korea) for the first time. This is also the northernmost locality of the species. Most probably *L. pallida* is a widely distributed species.

Comments — *Lepraria pallida* differs from other morphologically similar taxa of *Lepraria* with lobes and/or a black, tomentose hypothallus by the production of atranorin and zeorin, sometimes with accessory fatty acids (Sipman 2004, Flakus & Kukwa 2007). Only *L. caesiella* R.C. Harris contains the same set of secondary substances, but that species can be easily distinguished by its non-lobate, diffuse thallus (Lendemer 2005, Flakus & Kukwa 2007).

Specimens examined—**NORTH KOREA. Kumgangsan**, Manmulsan, on soil—30.09.1988, S. Huneck KDVR88-65 (B). **Rjongaksan**, etwa 12 km N von Pyongyang, auf senkrechter Fläche eines Granitblockes im Wald—23.09.1986, S. Huneck K86-27 (B).

Lepraria vouauxii (Hue) R.C. Harris, Bryologist 90: 163. 1987.
≡ *Crocynia vouauxii* Hue, Bull. Soc. Bot. France. 71: 392. 1924.

Morphology: This species has a quite variable morphology; its thallus may be unstratified, with diffuse margin and totally leprose surface or it may form stratified and irregular rosettes, which sometimes are obscurely lobed. The thallus colour is pale greenish grey, yellowish green or brownish yellow (e.g. Tønsberg 2004, Baruffo et al. 2006, Flakus & Kukwa 2007).

Chemistry: Pannaric acid-6-methylester (+) with related dibenzofurans and 'vouauxii unknown 1' (+) (see Tønsberg 1992) were found in the lichen. That agrees with the results presented by Leuckert & Kümmerling (1991), Tønsberg (1992), Kukwa (2006b) and Flakus & Kukwa (2007). Thallus C–, KC–, K–, and P+ orange or P–.

Ecology — *Lepraria vouauxii* was found on various types of substrate (Laundon 1989, Tønsberg 1992, Kukwa 2006b, Flakus & Kukwa 2007). The two specimens examined for this study were collected on rock.

Distribution — The species is known from all continents. It is very common in Europe, and most probably it is also common in other regions, also in the Neotropics, but so far rarely collected (e.g. Laundon 1989, Leuckert & Kümmerling 1991, Tønsberg 1992, Kukwa 2006b, Flakus & Kukwa 2007). Here it is reported as new to Jamaica.

Comments — *Lepraria sipmaniana* and *L. impossibilis* are the most similar species to *L. vouauxii* as both also contain pannaric acid-6-methylester. The

first species is easily distinguished by its broadly lobate thallus and the latter by the additional production of lecanoric acid. *L. vouauxii* also recalls *L. diffusa* (J.R. Laundon) Kukwa, but that species differs in the presence of large amounts of the dibenzofuran 4-oxypannaric acid-2-methyl ester (Laundon 1989, Sipman 2004, Tønsberg 2004, Flakus & Kukwa 2007).

Specimen examined—**JAMAICA. Blue Mountain District.** St. Andrew, trail from Clydesdales National Forest Camp to Morce's Gap and St. Helen's Gap, 1060–1220 m., Cloud Forest, on rock—17–27.12.1968, W.L. Culberson 13757 & 13759, C.F. Culberson (DUKE).

Lepraria yunnaniana (Hue) Zahlbr., in Handel-Mazzetti, Symb. Sin. 3: 244. 1930.
≡ *Crocynia yunnaniana* Hue, Bull. Soc. Bot. France 71: 396. 1924.
= *Lepraria nigrocincta* Diederich, Sérus. & Aptroot, in Aptroot et al., Biblioth. Lichenol. 64: 78. 1997.

Morphology: This species is characterized by a whitish to blackish prothallus on which whitish green soredia are formed (see Aptroot et al. 1997, Laundon 2008). In most Bolivian specimens the prothallus was extremely well developed and almost entirely blackish as in the specimens from Nepal cited by Kukwa (2006). Soredia were also more sparsely developed than in the type collection of *L. nigrocincta*, but the variability might be caused by the different habitat conditions. A picture of the specimen almost identical to our samples is presented by Aptroot & Sparrius (2008).

Chemistry: Divaricatic acid (+) with a trace of nordivaricatic acid (+) was detected. This agrees with the information provided by Aptroot et al. (1997) and Elix (2007). The thallus does not react with C, K or P; UV+ bluish.

Ecology — The Bolivian specimens were discovered in the montane cloud forests. The species is considered to be common in tropical mountains, where it grows on bark or corticolous bryophytes (e.g. Aptroot et al. 1997).

Distribution — This species can be considered as rather widely distributed. It was reported, mostly as *Lepraria nigrocincta*, from Africa (Burundi), Papua New Guinea (Aptroot et al. 1997), Australia (Elix 2007), Bhutan (Aptroot & Feijen 2002), China (Laundon 2008; type locality of *L. yunnaniana*), India (Upreti et al. 2003) and Nepal (Kukwa 2006b) in Asia and Costa Rica (Nelsen & Gargas 2008) and Ecuador (Nöske et al. 2007) in Latin America. Here it is reported as new to Bolivia.

Comments — Only three *Lepraria* species produce divaricatic acid, *L. crassissima* (Hue) Lettau, *L. incana* and *L. yunnaniana*. However, only *L. yunnaniana* produces a thick and dark hypothallus and lacks zeorin (Aptroot et al. 1997, Kukwa 2006, Laundon 2008). Some other taxa may also develop a blackish hypothallus, e.g. *L. cupressicola* (syn. *L. atrotomentosa*; see Laundon

2008) or *L. pallida*, but they do not produce divaricatic acid (Orange et al. 2001b, Sipman 2004, Flakus & Kukwa 2007).

The name *Lepraria yunnaniana* was forgotten for a very long time and the species was better known as *L. nigrocincta*. However, Laundon (2008) recently proved both taxa to be conspecific.

Specimen examined—**BOLIVIA. East Cordillera.** Dept. Cochabamba, Prov. Chapare, near Incachaca village, 17°14'17"S, 65°48'54"W, alt. 2400 m, on bryophytes—10.06.2006, A. Flakus 7890 (KRAM, LPB, herb. Flakus). Prov. Carrasco, Carrasco National Park, between Sehuencas and Monte Punku villages, on saxicolous bryophytes—27.07.2008, A. Flakus 10702, M. Kukwa 6574 & 6582 & P. Rodriguez (KRAM, LPB, UGDA, herb. Flakus).

Reference material examined—**BURUNDI.** Galerie forestière de la Siguvyaye un peu en aval du pont de la route Rumonge-Bururi. env. 1750 m. Dans le bas d'un gros tronc de Carapa—20.09.1974, J. Lambinon 74/1266 (isotypi of *Lepraria nigrocincta*, BG-L, herb. Diederich).

Lepraria zeorinica (L. Saag) Kukwa, **stat. et comb. nov.**

MycoBank MB 512681

Basionym: *Lepraria alpina* var. *zeorinica* L. Saag, in Saag et al., Mycotaxon 102: 68. 2007.

Morphology: The thallus is typical for members of the *Lepraria neglecta* group: thick, coarsely granular, with diffuse margin, dark grey with bluish tinge. It forms irregular patches on the substrate (Saag et al. 2007).

Chemistry: Atranorin (+), angardianic/roccellic acid (+) with additional unidentified fatty acid (observed only in solvent C), porphyrilic acid (+) and zeorin (+) (Diederich 15711) or atranorin (+), porphyrilic acid (+), zeorin (+) and 2 fatty acids (+): one chromatographically very similar to rangiformic acids in solvents A and C, but in lower position in solvent B, second one identical to angardianic/roccellic acid in solvent C, but with higher Rf values in solvent A and B (all other cited specimens). The variation of fatty acids appears to be higher than that presented by Saag et al. (2007) and needs further studies.

Ecology — The specimens from France were collected on schist rich in pyrite. It is also known on bryophytes and soil, and sometimes reported from thalli of other lichens (Saag et al. 2007).

Distribution — So far, *Lepraria zeorinica* has been known from Greenland only (Saag et al. 2007). Here it is reported for the first time in Europe from France.

Comments — The delimitation of the taxa in the *Lepraria neglecta* group, based actually exclusively on chemical characters, was always problematic. The presence or absence of secondary lichen substances in some cases was considered as species diagnostic and that rank was proposed e.g. for *L. neglecta*

(Nyl.) Erichsen or *L. borealis* Loht. & Tønsberg (Lohtander 1994), but in case of *L. caesioalba* (B. de Lesd.) J.R. Laundon the differences in depsidone constituents were treated as chemical variation within one species (Leuckert et al. 1995, Tønsberg 2004). However, recent molecular approaches proved that the secondary metabolites are valuable discriminators for those superficially indistinguishable species. It was shown that a single major substance (often with biochemically closely related metabolites), especially in case of fatty acids can be considered as diagnostic for evolutionary lineages, even when the morphology does not support a distinction between two species. This is the case e.g. in *L. borealis* and *L. granulata* Slav.-Bay., differing only in fatty acids, and the chemotypes of *L. caesioalba*, perhaps each of them deserving species status (Ekman & Tønsberg 2002, Slavíková-Bayerová & Fehrer 2007). A similar relation was also proven for the *L. jackii* group, where the secondary chemistry, and not the morphology, confirms the distinction of taxa (Fehrer et al. 2008).

Lepraria zeorinica was described as a variety of *L. alpina* (B. de Lesd.) Tretiach & Baruffo, a species with porphyrilic acid, and the only difference was the presence of zeorin in the former (Saag et al. 2007). Saag et al. (2007) discussed that the presence of one additional metabolite cannot be considered as a discriminating character at species level, but only at variety level. In our opinion, however, zeorin as a unique substance not related to any other known in *L. alpina*, should be treated as a feature distinguishing species, not varieties, especially because in the morphologically uniform *L. neglecta* group the chemistry bears a great diagnostic value. Therefore, a new combination and status for *L. alpina* var. *zeorinica* is proposed above. Zeorin is also a distinguishing character between, e.g., *L. incana* and *L. yunnaniana*, and *L. lobificans* and *L. multiacida*. However, in those cases the morphology confirms the distinction indicated by the chemistry (see above under *L. lobificans* and *L. yunnaniana*).

Lepraria zeorinica is morphologically indistinguishable from other members of the *L. neglecta* group: *L. alpina*, *L. borealis*, *L. caesioalba*, *L. granulata* and *L. neglecta*; however none of these produce zeorin and porphyrilic acid together (Saag et al. 2007, 2009).

Specimens examined—**FRANCE. Ardennes.** Distr. ardennais, Fumay, roadside S of the town, on the left side of Meuse river, 125 m, outcrop of black schist and quartzite belonging to the Revinian, rich in pyrite, water almost permanently oozing, on schist—01.05.1999, P. Diederich 15711 (herb. Diederich); ibidem—23.11.2008, D. Ertz, M. Kukwa 7306 & 7408 (BR, UGDA).

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Gasteroid mycobiota of Rio Grande do Sul, Brazil: *Tulostomataceae*

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Abstract — The diversity of *Tulostomataceae* has been investigated in Rio Grande do Sul State in southern Brazil. Eight species belonging to two genera were recognized: *Battarrea,* represented by *B. phalloides,* and *Tulostoma,* represented by *T. brasiliense, T. cyclophorum, T. dumeticola, T. exasperatum, T. pygmaeum, T. rickii,* and *T. striatum.* All species are described and illustrated by line drawings and photos, including scanning electron micrographs of the basidiospores. Illustrations of the peridium structure are furnished for most taxa.

Key words — *Agaricales,* gasteromycetes, stalked puffballs

Introduction

The family *Tulostomataceae* E. Fisch. (*Basidiomycota*) comprises stalked puffballs belonging to the genera *Battarrea* Pers., *Battarreoides* T. Herrera, *Chlamydopus* Speg., *Queletia* Fr., *Schizostoma* Ehrenb. ex Lév., and *Tulostoma* Pers. (Kirk et al. 2001). Among these, only *Battarrea* and *Tulostoma* have been reported in Brazil, although species of *Chlamydopus*, *Queletia*, and *Schizostoma* are known in Argentina and other neighboring countries (Wright 1949, Mahú 1980, Dios et al. 2004). *Tulostoma* is the largest genus, with more than 140 species, occurring mainly in xerophilous habitats, and to a lesser extent, in forest environments (Wright 1987).

Tulostomataceae was recently included in the *Agaricales* Underw. based on studies of molecular systematics (Moncalvo et al. 2002); within this order, it has been considered as a separate family (Kirk et al. 2001) or merged into the heterogeneous *Agaricaceae* Chevall. (Vellinga 2004), which currently includes agaricoid, secotioid, and gasteroid members (Kirk et al. 2008).

In Brazil, studies on *Tulostomataceae* were done by Rick (1907, 1930, 1961), who reported seven *Tulostoma* and one *Battarrea* from Rio Grande do Sul State. Batista & Vital (1955) described three new *Tulostoma* from Pernambuco (*T. heroicum* Bat. & A.F. Vital, *T. nanicum* Bat. & A.F. Vital and *T. recifense* Bat. & A.F. Vital), all of them now considered synonyms of *T. cyclophorum* (Wright 1987). In his world monograph of *Tulostoma*, Wright (1987) reported eight species in Brazil, mostly from Rio Grande do Sul State. More recently, new data on *Tulostomataceae* in areas of northeastern (Baseia & Galvão 2002, Silva et al. 2007a, b), southeastern (Baseia & Milanez 2002), and southern (Cortez et al. 2008a, b) Brazil have improved the knowledge on the distribution of the group in the country.

The aim of this work is to revise the *Tulostomataceae* in Rio Grande do Sul State mycobiota based on study of fresh and herbarium specimens.

Materials and methods

Specimens were collected from 2006 to 2008 in Rio Grande do Sul State, southern Brazil. Specimens from the herbaria BAFC, HURG, ICN, PACA, and SMDB were revised. Descriptive terminology and taxonomy is based in Wright (1987). Color codes follow Kornerup & Wanscher (1978). Scanning electron microscopy (SEM) studies were performed at the Universidade Federal do Rio Grande do Norte with a Phillips XL 20, following previously described methods (Cortez et al. 2008c). All collected specimens are deposited at the herbarium ICN, with some duplicates at UFRN and SMDB.

Taxonomy

Key to the *Tulostomataceae* of Rio Grande do Sul State, Brazil

1.	Volva present, mouth absent, elaters present	1. *Battarrea phalloides*
1'.	Volva absent, mouth present, capillitium present (*Tulostoma*)	2
2.	Mouth tubular	3
2'.	Mouth circular, fimbriate to indistinct	4
3.	Exoperidium hyphal	6. *T. pygmaeum*
3'.	Exoperidium membranous	2. *T. brasiliense*
4.	Growing on wood, exoperidium spiny	5. *T. exasperatum*
4'.	Growing on soil, litter or sand, exoperidium not spiny	5
5.	Growing on sand or sandy soil, stipe smooth	8. *T. striatum*
5'.	On soil or litter in forests, stipe scaly to lacerated	6
6.	Mouth mammose, fimbriate	3. *T. cyclophorum*
6'.	Mouth circular, fimbriate	7
7.	Stipe with a bulbous, pseudovolvate base	7. *T. rickii*
7'.	Stipe with an expanded, not bulbous, base	4. *T. dumeticola*

Description of the studied taxa

1. *Battarrea phalloides* (Dicks.) Pers., Syn. Meth. Fung.: 129, 1801. FIG. 1–4, 44

Basidiomata 195–330 mm high, epigeous in mature stage. Spore sac 22–60 × 16–21 mm, hemispheric, brown (6E5) to light brown (6D5), upper surface velutinous to densely fibrillose and dry, margin crenate to eroded. Mouth absent. Gleba pulverulent, light brown (6D6). Stipe 190–313 × 5–22 mm, cylindrical to slightly sinuous, surface scaly to fibrous, light brown (6D7) to brown (6D8), hollow, base volvate. Volva membranous, presenting similar color and surface as the stipe, partially adhered to the stipe base.

Basidiospores 5–6 µm diam. (including ornamentation), subglobose to globose, yellowish brown in KOH, with an ornamentation composed by short cylindrical spines; under SEM, the ornamentation is composed by warts and short spines which are anastomosed forming a subreticulate pattern. Pseudocapillitium 3–5.5 µm diam. hyphae, yellowish to hyaline, with thin walls, septa and branching uncommon. Elaters 3.5–6 µm diam., cylindrical, hyaline, with thickened spiral ornamentation, little branched.

EXAMINED SPECIMENS: BRAZIL. Rio Grande do Sul State. **Nova Petrópolis**, X.1994, *G. Sobestiansky* (ICN 102570), in subtropical ombrophilous forest; **Tupanciretã**, Taquarembó, *J. Rick* (PACA 12606).

ADDITIONAL SPECIMENS: ARGENTINA. **Salta Province**, 1983, *R.T. Guerrero* (ICN 97585).

DISTRIBUTION: worldwide in xerophilous areas (Watling et al. 1995, Esqueda et al. 2002). Brazil: Pernambuco (Silva et al. 2007b, as *B. stevenii*) and Rio Grande do Sul (Rick 1961, Sobestiansky 2005).

DISCUSSION: This fungus can be considered a rare species in Rio Grande do Sul, since only herbarium specimens were studied. It usually occurs in sandy and dry areas, but the Sobestiansky (2005) collection was gathered in ombrophilous forest of south Brazil. *Battarrea stevenii* (Libosch.) Fr., considered a distinct species by many authors (Watling et al. 1995), was shown to be synonym of *B. phalloides* based on morphological and molecular data (Martín & Johannesson 2000, Jeffries & McLain 2004). The differences in basidiomata size and consistency of the volva – the main features used to separate them – are due to variation in the environmental factors of their habitats (Jeffries & McLain 2004).

2. *Tulostoma brasiliense* J.E. Wright, Ciencia 27: 112, 1972.

DESCRIPTION: see Wright (1987) and Wright et al. (1972).

DISTRIBUTION: southern hemisphere. Brazil, Argentina and Australia (Wright 1987, Grgurinovic 1997). Brazil: Rio Grande do Sul (Wright et al. 1972).

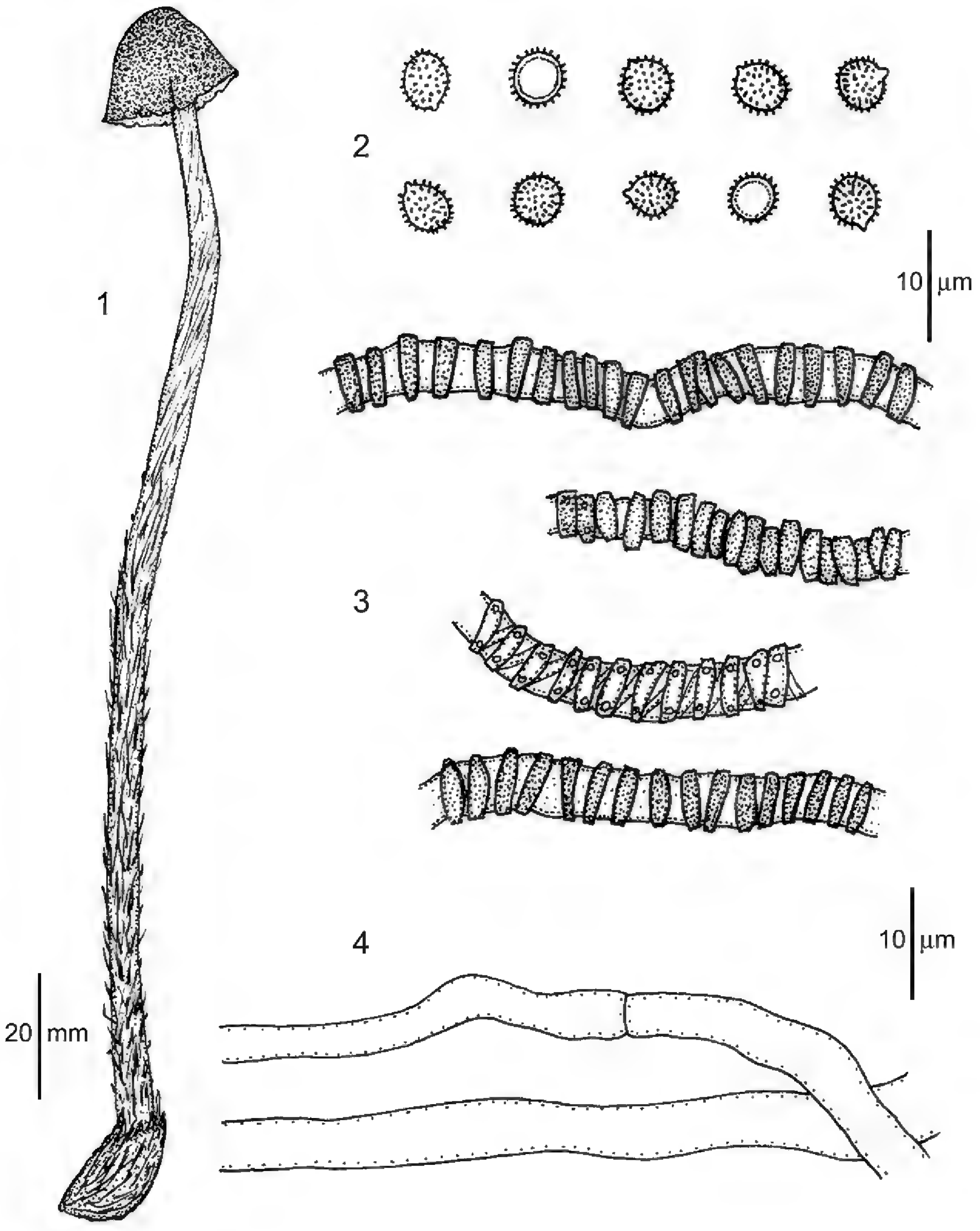

FIG. 1–4. *Battarrea phalloides.*
1. Basidioma. 2. Basidiospores. 3. Elaters. 4. Pseudocapillitium.

DISCUSSION: *Tulostoma brasiliense* is known in Brazil only from the holotype, preserved at Lloyd's herbarium (BPI). Unfortunately, the type was requested but could not be studied because it was lost during mail sending. For this reason its description is not presented here. According to Wright (1987), it resembles

T. xerophilum Long in some aspects but this species has minutely echinulate basidiospores, in contrast to verrucose basidiospores of *T. brasiliense*. In spite of our efforts to recollect *T. brasiliense*, no specimens were gathered, a common situation for many species described and reported by J. Rick.

3. *Tulostoma cyclophorum* Lloyd, Tylostomeae: 25, 1906. FIG. 5–10, 45

Basidiomata 51–67 mm high. Spore sac 13–16 mm diam., 9–11 mm high, hemispheric to depressed-globose. Exoperidium membranous, mostly seen on young basidiomes, loosing from endoperidium as plates in maturity, light brown (6D5) to brown (6E5) externally, and white inside. Endoperidium membranous to tough, with a furfuraceous surface due to the numerous mycosclereids, color brownish orange (5C3) to dark blond (5D4). Mouth definite, fibrillose-fimbriate, mammose, color the same of the endoperidium. Socket conspicuous, well-developed, separate from the stipe, forming a membranous, scaly to lacerate collar around the stipe apex. Gleba lanose to little pulverulent when mature, brownish yellow (5C7) to golden brown (5D7). Stipe 45–62 × 2.5–4 mm, cylindrical to slightly curved, base expanded, with abundant, thin rhizomorphs, surface longitudinally striate with scattered scales (decortications of stipe surface), color brown (6E5), fistulose, with white context.

Basidiospores 3.8–5 × 3.4–4.2 µm diam. (including ornamentation), ovoid to subglobose, with a verrucose ornamentation under light microscopy, stramineous in KOH; under SEM the ornamentation the warts are anastomosed, forming a reticulum. Capillitium 3.4–8.4 µm diam. hyphae, with hyaline to stramineous walls, moderately thickened, septate and little branched. Endoperidium formed by mycosclereids 72–226 × 20–28 µm, short to elongated, some with nodules or irregular branches, walls thickened, yellow to brownish yellow in KOH, present in the endoperidium surface.

EXAMINED SPECIMENS: BRAZIL. Rio Grande do Sul State. **Ibirapuitã:** 08.IV.2007, *R. Sühs* (SMDB 11.118). **Porto Alegre:** *Schneider* (PACA 22185, as *T. pygmaeum*); Chácara Irmãos Maristas, 01.VI.1968, *Feliciano* (ICN 5365); Morro Santa Teresa, 10.V.1971, *M.L. Lorscheitter* (ICN 6221). **Rio Grande:** FURG Capus Carreiros, 18.III.1991, *B. Vall* (HURG 3590); Cassino, 18.III.1992, *A. Görgen* (HURG 3712); Querência, 16.VII.199, *T.S. Gonzalez* (HURG 3792). **Santa Cruz do Sul:** UNISC, 18.VI.2007, *M.A. Sulzbacher 112* (SMDB 11.119). **Santa Maria:** 1935, *J. Rick* (PACA 15074, 15081, 15087); 1936, *J. Rick* (PACA 15084). **São Leopoldo:** *J. Rick* (PACA 15085, as *T. rickii*); 1930, *J. Rick* (PACA 15069, 15072); 1936, *J. Rick* (BAFC 51652). **Viamão:** Schöenwald, 19.V.1965, *M.H. Homrich* (ICN 3653, 3655), 21.VII.1965, *R. Schöenwald* (ICN 3777), 14.VIII.1965, *Schöenwald* (ICN 3837).

ADDITIONAL SPECIMENS: ARGENTINA. **Buenos Aires:** Estación Experimental Central, 30.V.1956, *A. Marzzocca* (ICN 3513). URUGUAY. **Montevideo:** Tonkinson, 28.IV.1934, *W.G. Herter* (PACA 94552).

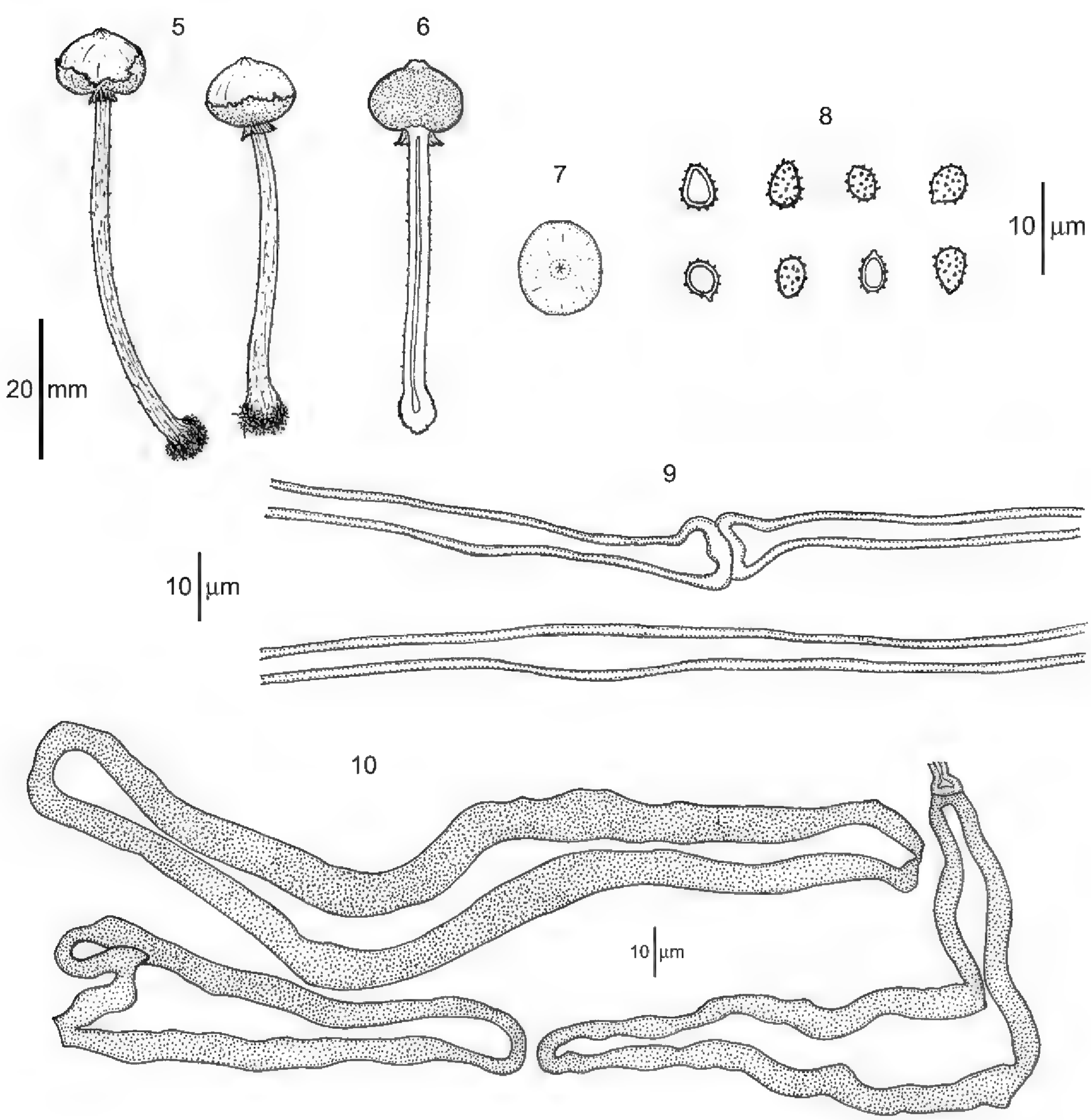

Fig. 5–10. *Tulostoma cyclophorum*.
5. Basidiomata. 6. Section of basidioma. 7. Top view of spore sac.
8. Basidiospores. 9. Capillitium. 10. Mycosclereids.

Distribution: worldwide (Wright 1987). Brazil: Rio Grande do Norte (Silva et al. 2007a), Pernambuco, Rio de Janeiro, Santa Catarina, and Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma cyclophorum* was considered by Wright (1977) to be a synonym of *T. pampeanum* (Speg.) J.E. Wright. However, as pointed out by Demoulin (1984), Wright's new combination does not have priority at the species level because the epithet '*pampeanum*' was originally described in the rank of form. The combination of membranous exoperidium, mammose mouth and the presence of mycosclereids on endoperidium are the diagnostic features of the species (Wright 1987). *Tulostoma cyclophorum* was previously reported

in Rio Grande do Sul by Rick (1930, 1961), Wright (1987) and Guerrero & Homrich (1999, as *T. berteroanum*).

4. *Tulostoma dumeticola* Long, Lloydia 10: 117, 1947. Fig. 11–16, 24, 46

Basidiomata 21–81 mm high. Spore sac 10–23 mm diam., 8–12 mm high, hemispheric to depressed-globose. Exoperidium hyphal, velutinous to verrucose, composed by short, deciduous warts, irregularly loosing from the endoperidium, dark brown (6F5) to reddish brown (8F4). Endoperidium tough, with a smooth surface, color light brown (6D7), seen only in older basidiomes. Mouth definite, circular to elliptical, slightly projecting but not tubular, except in young basidiomes when unopened, color little distinct from the remaining endoperidium. Socket conspicuous, separate from the stipe, forming a lacerate but not membranous collar around the stipe apex. Gleba little pulverulent when mature, golden brown (5D7) to yellowish brown (5D8). Stipe 14–66 × 2.5–7 mm, cylindrical or compressed, erect to slightly incurved, with an expanded base composed by numerous and thin rhizomorphs, surface scaly-fibrillose, formed by longitudinally arranged scales (decortications of the stipe surface), color dark brown (6F7) to light brown (7D7), fistulose, context white.

Basidiospores 5–6 × 3.8–5 µm diam. (excluding ornamentation) or 6.2–7.2 × 5–6.2 µm diam. (including ornamentation), subglobose to globose, with a spiny ornamentation under light microscope, yellowish brown in KOH; under SEM the ornamentation is formed by conical anastomosed spines. Capillitium 2.5–8.4 µm diam. hyphae, with hyaline to stramineous walls, moderately thickened, lumen of variable diameter along the hyphae, septate and little branched (dichotomous). Exoperidium formed by fascicles of brown, thick-walled mycosclereids, mostly subcylindrical to irregular hyphae, 67–130 × 8–20 µm, covering the endoperidium surface. Endoperidium composed by short, subglobose, globose or irregular cells, with thick walls (mycosclereids), pale yellowish in KOH, 11–27 × 9–21 µm.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Caçapava do Sul:** Pedra do Segredo, 01.V.2005, *V.G. Cortez 037/05* (SMDB 11.120). **Santa Maria:** Morro do Elefante, 12.IV.2003, *V.G. Cortez 040/03* (UFRN); Morro da Caturrita, 02.V.2006, *G. Coelho & V.G. Cortez 030/06* (ICN). **São Leopoldo:** *J. Rick* (PACA 15076); 1905, *J. Rick* (PACA 15089, as *T. verrucosum*); 1907, *J. Rick* (PACA 15086); 1930, *J.Rick* (PACA 15088, as *T. squamosum*). **Viamão:** 10.VI.1970, *M.H. Homrich & F.R. Schöenwald* (ICN 6146).

Distribution: Neotropical, widespread in South America (Wright 1987), Costa Rica (Calonge & Mata 2006) and Mexico (Guzmán et al. 1992). Brazil: Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma dumeticola* is distinguished by the verrucose, brown exoperidium, circular mouth, scaly stipe, and basidiospores with cylindrical warts under light microscope (Wright 1987). As shown under the SEM, the

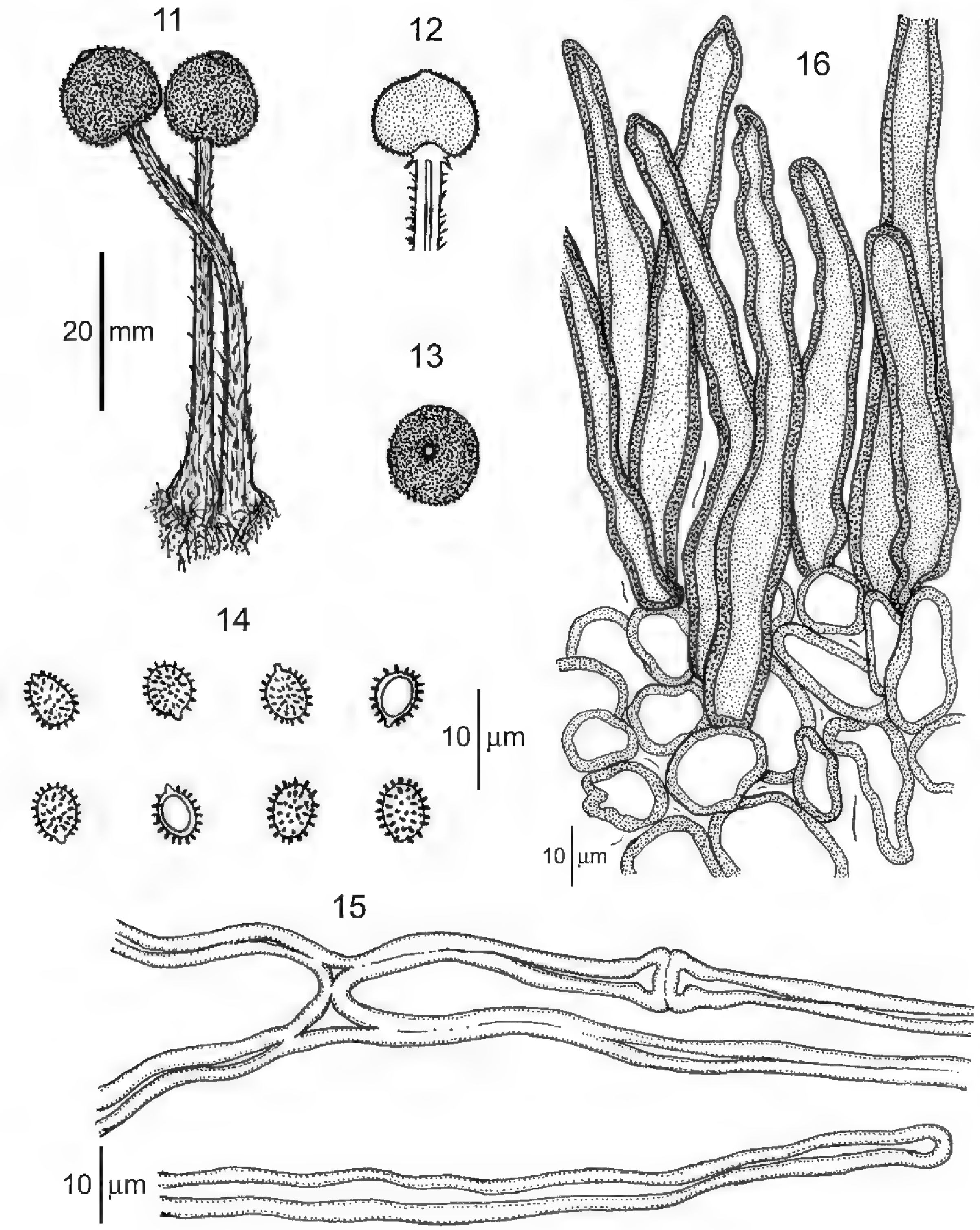

FIG. 11–16. *Tulostoma dumeticola.*
11. Basidiomata. 12. Partial section of basidioma. 13. Top view of spore sac.
14. Basidiospores. 15. Capillitium. 16. Detail of the exo- and endoperidium.

anastomosed crests on the basidiospores form a reticulate ornamentation. *Tulostoma matae* Calonge & J. Carranza, described from Costa Rica, is macroscopically similar, however differs in the ovoid to elliptical basidiospores (Calonge & Carranza 2003). As *T. exasperatum* and *T. rickii*, this species grows in subtropical forests of Rio Grande do Sul.

5. ***Tulostoma exasperatum*** Mont., Ann. Sci. Nat., Bot. Ser. 2, 8: 362, 1837.

Fig. 17–23, 25, 47

Basidiomata 25–50 mm high, growing solitary or gregarious on wood. Spore sac 13–17 mm diam., 8–11 mm high, hemispheric to depressed-globose. Exoperidium spiny, formed by short and conical spines of variable size (<1.5 mm in length), being more longer in younger basidiomes, color dark brown (6F8), becoming deciduous in maturity, falling from center/apex toward the margin/base of the spore sac, leaving conspicuous scars on endoperidium surface. Endoperidium papery to membranous, with a reticulate aspect due to the fall of the exoperidium spines, which leaves circular scars on endoperidium surface, color grayish orange (5B3) to brownish orange (5C3). Mouth definite, fibrillose-fimbriate, circular, slightly projecting to mammose, color little distinct from the remaining endoperidium. Socket present but inconspicuous, little separate from the stipe apex, and not forming a membranous collar. Gleba little pulverulent, brownish grey (5C3) to yellowish brown (5D5). Stipe 17–42 × 2.5–4 mm, cylindrical, straight to slightly incurved, with an expanded rhizomorphic base, surface wholly scaly, formed by longitudinally arranged scales (decortications of the stipe surface), color dark brown (6F8), fistulose, with flesh white to pale orange (5A3).

Basidiospores 4.5–6.5 µm diam. (excluding ornamentation) or 7.5–9.2 µm diam. (including ornamentation), globose, yellowish in KOH, with a reticulate ornamentation in light microscopy; under SEM, the clathrate pattern is observed. Capillitium 3.5–7.5 µm diam. hyphae, with stramineous and moderately thickened walls, lumen of variable diameter along the hyphae, septate and dichotomously branched. Exoperidium formed by fascicles of yellowish brown hyphae of variable shape, which form the spines of the exoperidium, usually short and with little thickened walls, very close. Endoperidium composed by long, subcylindrical to sinuous hyphae, 7.5–20 µm diam., with much thickened walls (mycosclereids), sometimes without a visible lumen, yellow in KOH.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Campo Bom:** Estação Ecológica Municipal, 30.V.2007, *G.B. Ceolin & M.A. Reck* (ICN). **São Leopoldo:** 1930, *J. Rick* (PACA 15070); 1931, *J. Rick* (PACA 15083); 1932, *J. Rick* (BAFC 51656), *J. Rick* (PACA 15073, 15075, 15079, 15085). **Viamão:** Parque Estadual de Itapuã, 22.V.2004, *V.G. Cortez 034/04* (UFRN); 25.VI.2005, *R.M. Silveira 456* (ICN). No data (ICN 56084).

Distribution: Pantropical, in the Americas, Africa and Asia. Brazil: Paraíba, Pernambuco (Baseia & Galvão 2002), São Paulo (Bononi et al. 1984), Paraná (Meijer 2006), Santa Catarina, and Rio Grande do Sul (Wright 1987, Cortez et al. 2008a).

Discussion: *Tulostoma exasperatum*, like *T. cyclophorum* and *T. dumeticola,* is among the most abundant representatives of the genus in the area. The specimens grow solitary to densely gregarious on wood, as observed in several collections.

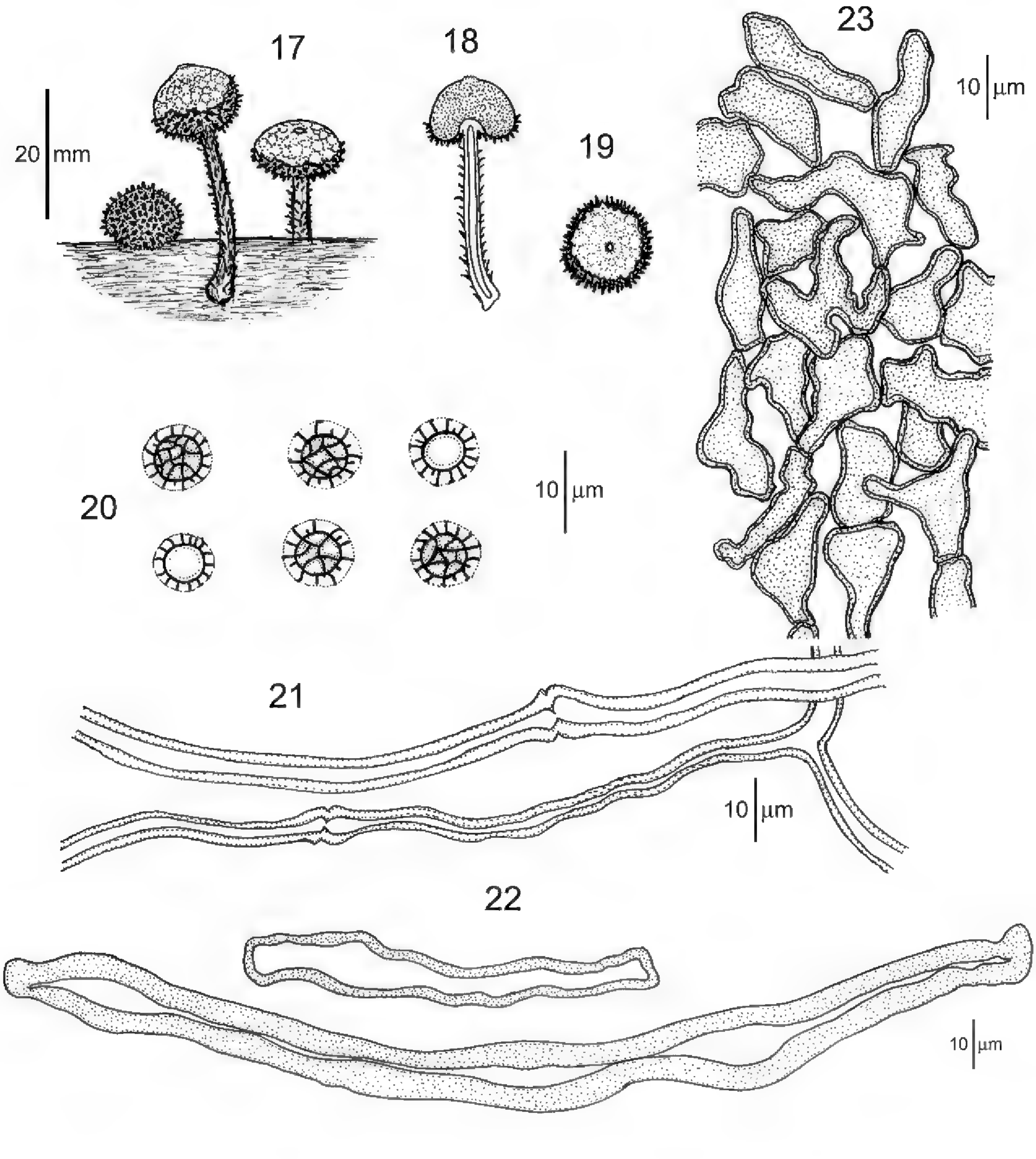

Fig. 17–23. *Tulostoma exasperatum*.
17. Basidiomata. 18. Section of basidioma. 19. Top view of spore sac. 20. Basidiospores. 21. Capillitium. 22. Endoperidium (mycosclereids). 23. Exoperidium.

The spiny exoperidium, reticulate ornamentation of the basidiospores, and lignicolous habit are the diagnostic features of this species (Wright 1987). Its distribution extends from Northeastern to South Brazil.

Although not described by Wright (1987), the endoperidium structure of *T. exasperatum* under light microscope presents similar hyphal elements to those of *T. cyclophorum*, which this author called mycosclereids. These thick-walled hyphae are found in other species like *T. dumeticola* and *T. matae*, and their presence is taxonomically significant in *Tulostoma*.

Fig. 24. *Tulostoma dumeticola* (Photo: G. Coelho).
Fig. 25. *Tulostoma exasperatum* (Photo: G.B. Ceolin).

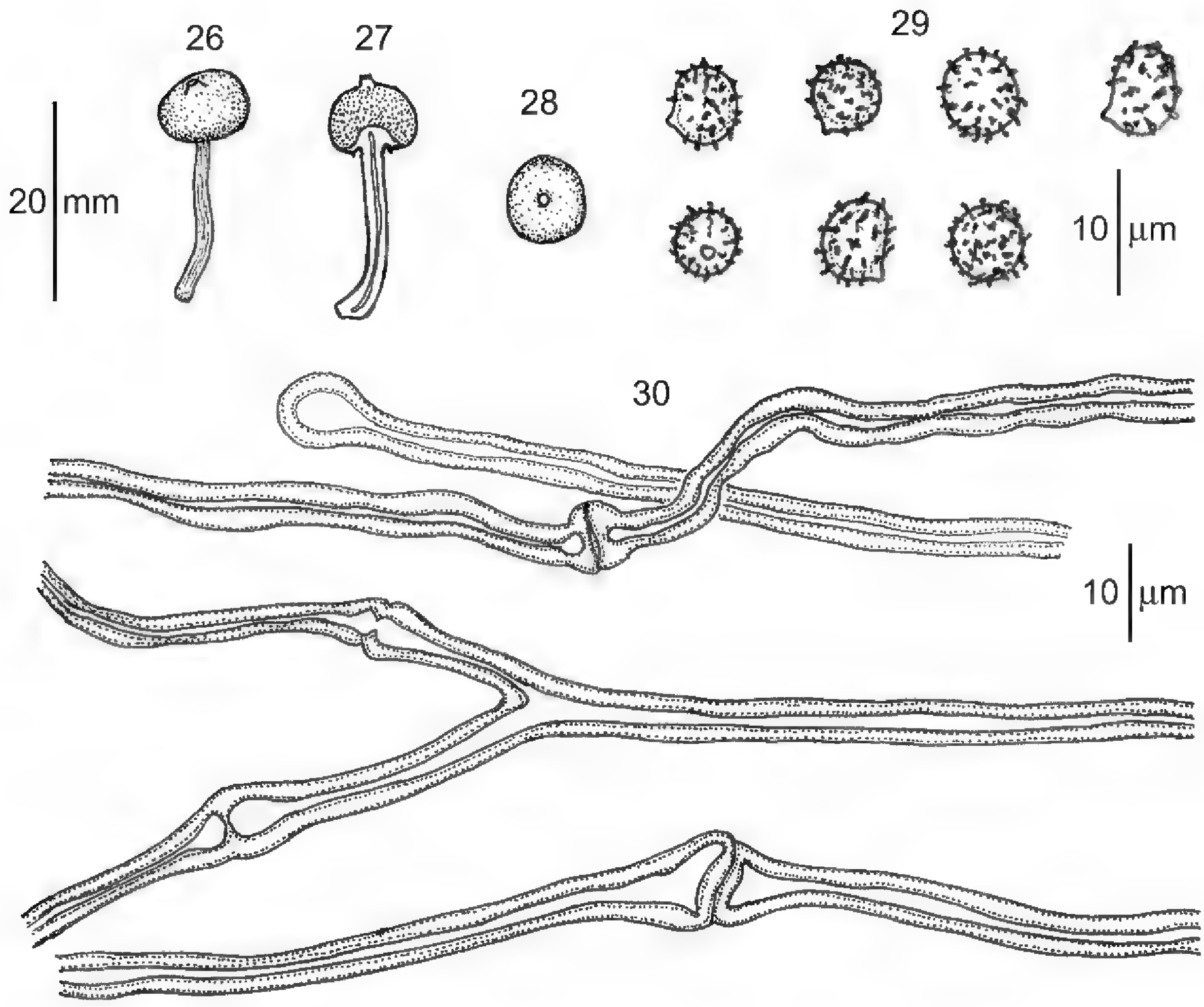

FIG. 26–30. *Tulostoma pygmaeum.*
26. Basidioma. 27. Section of basidioma. 28. Top view of spore sac.
29. Basidiospores. 30. Capillitium.

6. *Tulostoma pygmaeum* Lloyd, Tylostomeae, 16, 1906. FIG. 26–30, 37, 48

Basidiomata 20–23 mm high, with hypogeous stipe in early stages, then epigeous at maturity. Spore sac 8–12 mm diam., depressed-subglobose. Exoperidium hyphal, indistinct, appearing as remnants at the base of the endoperidial body, incrusted with soil particles and providing a verrucose aspect. Endoperidium papery, with a granulose to smooth surface, grey (6B1) to white (6A1). Mouth tubular, well-defined and projecting, with entire margin. Socket inconspicuous, very close to the stipe. Gleba pulverulent when mature, light brown (6C6–6C5). Stipe 16–18 × 2–3 mm, sometimes completely buried, slightly sinuous, surface with longitudinal striae and little scaly surface, brownish orange (5C4), base little expanded, fragile, hollow, with white context.

Basidiospores 6–7.5(–8.5) × 5.5–7.5 µm diam. (including ornamentation), subglobose to globose, with a coarsely verrucose to echinate ornamentation; under SEM the irregular ornamentation is formed by spines and warts which

sometimes are anastomosed. Capillitium 3.5–5(–7.5) µm diam. hyphae, with stramineous, thickened walls, with scattered and broad (7–12 µm) septa, and capitate apex. Exoperidium and endoperidium little differentiated from capillitium hyphae.

Examined specimens: BRAZIL. Rio Grande do Sul State. **Caçapava do Sul,** BR 392, 17.II.2008, *V.G. Cortez 028/08* (ICN), *V.G. Cortez 031/08* (ICN). **Santa Maria,** Parque Itaimbé, 28.V.2008, *V.G. Cortez 098/08* (ICN), 09.VI.2008, *V.G. Cortez 116/08* (ICN), 19.VI.2008, *V.G. Cortez 119/08* (SMDB 11.523).

Distribution: Africa, Australasia, Americas (Wright 1987).

Discussion: *Tulostoma pygmaeum* was described from North America, where it has been reported in xerophilous environments (Wright 1987). According to Moreno et al. (1995), the diagnostic features of the species are its small size, tubular mouth, hyphal exoperidium, and basidiospore ornamentation. Wright (1987) also noted the fragile nature of the stipe, a feature clearly observed in our studied specimens. Rick (1961) cited *T. pygmaeum* as "hic non inventum," only suspecting that it might occur in Rio Grande do Sul. However, we have located one specimen preserved at the herbarium PACA as *T. pygmaeum*, but the material is actually *T. cyclophorum* (see examined specimens). With the present finding, its occurrence in Brazil is confirmed.

7. ***Tulostoma rickii*** Lloyd, Tylostomeae: 20, 1906. Fig. 31–36, 38, 49

Basidiomata 56–81 mm high, epigeous. Spore sac 18–23 mm diam., subglobose. Exoperidium membranous, light orange (5A5) to yellowish brown (5D8), incrusted with soil particles, providing a verrucose surface. Endoperidium membranous, with a granulose surface light orange (5A4), adhered to the exoperidium. Mouth fimbriate, almost indistinct. Socket conspicuous to inconspicuous, with a membranous consistency, scaly. Gleba pulverulent when mature, brownish yellow (5C7) to golden brown (5D7). Stipe 42–71 × 5–7 mm, slightly sinuous, with longitudinal striae, scaly surface, light orange (5A5) to yellowish brown (5D6), base volviform with abundant soil particles adhered, hollow with white flesh.

Basidiospores 4.2–5 µm diam. (ornament excluded) or 6.7–8.4 µm (including ornamentation), globose, with a distinct reticulate ornamentation, which represent the 'wings' or 'spines' in optical section; under SEM, the clathrate pattern is observed. Capillitium 4.2–8.4 µm diam. hyphae, with hyaline to stramineous thickened walls, septate. Exoperidium formed by yellowish brown, thin-walled, interwoven and mostly collapsed hyphae, 2.5–5.5 µm diam. Endoperidium formed by hyaline, interwoven hyphae, with slightly thickened walls, 2–5 µm diam.

Examined specimens: BRAZIL. Rio Grande do Sul State. **São Leopoldo:** 1930, *J. Rick* (PACA 15072); spores of the holotype preserved at BAFC (51654).

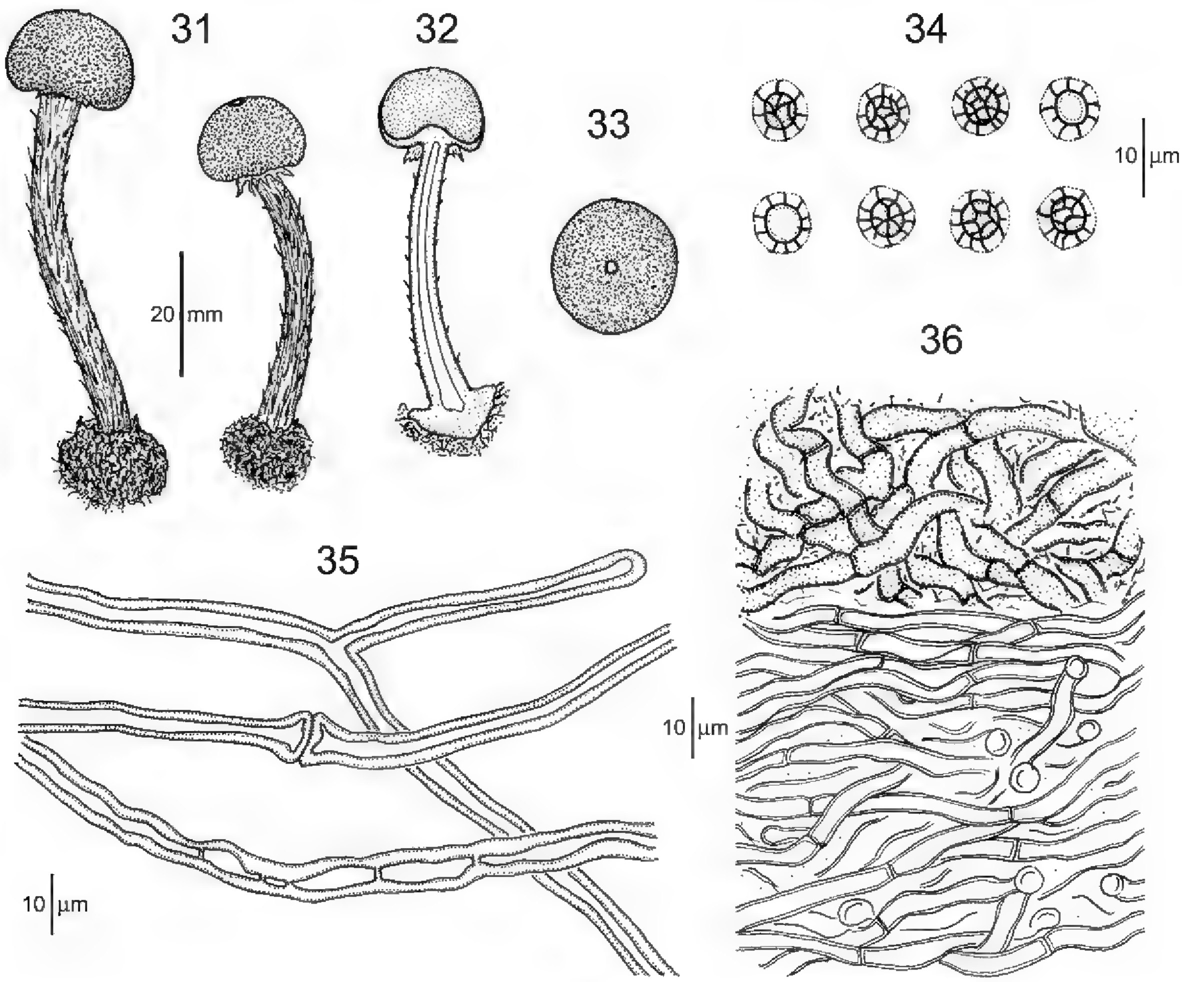

FIG. 31–36. *Tulostoma rickii.*
31. Basidiomata. 32. Section of basidioma. 33. Top view of spore sac.
34. Basidiospores. 35. Capillitium. 36. Detail of the exo- and endoperidium.

ADDITIONAL SPECIMENS: Santa Catarina State. **Riqueza:** 27.XII.2006, *A.A. Spielmann & M.A. Sulzbacher 86* (SMDB 10.999).

DISTRIBUTION: subtropical South America (Argentina and Brazil). Brazil: Santa Catarina (Cortez et al. 2008b) and Rio Grande do Sul (Wright 1987).

DISCUSSION: *Tulostoma rickii* is characterized by the presence of a bulbous stipe base, resembling a volva and the reticulate basidiospores (Wright 1987). The latter are similar to those of *T. exasperatum*, but this is a lignicolous species with a conspicuously spiny exoperidium. Wright (1987) considered it a rare species, with known reports from Rio Grande do Sul (Rick 1961) and Santa Catarina (Cortez et al. 2008b) in Brazil, and northern Argentina.

8. *Tulostoma striatum* G. Cunn., Proc. Linn. Soc. N.S.W. 50: 255, 1925.

Fig. 39–43, 50

Basidiomata 23–30 mm high, growing on sand or sandy soil. Spore sac 8–10 mm diam., 9–10 mm high, globose. Exoperidium membranous, usually covered with sand grains and disappearing in older specimens. Endoperidium

FIG. 37. *Tulostoma pygmaeum* (Photo: V.G. Cortez).
FIG. 38. *Tulostoma rickii* (Photo: A.A. Spielmann).

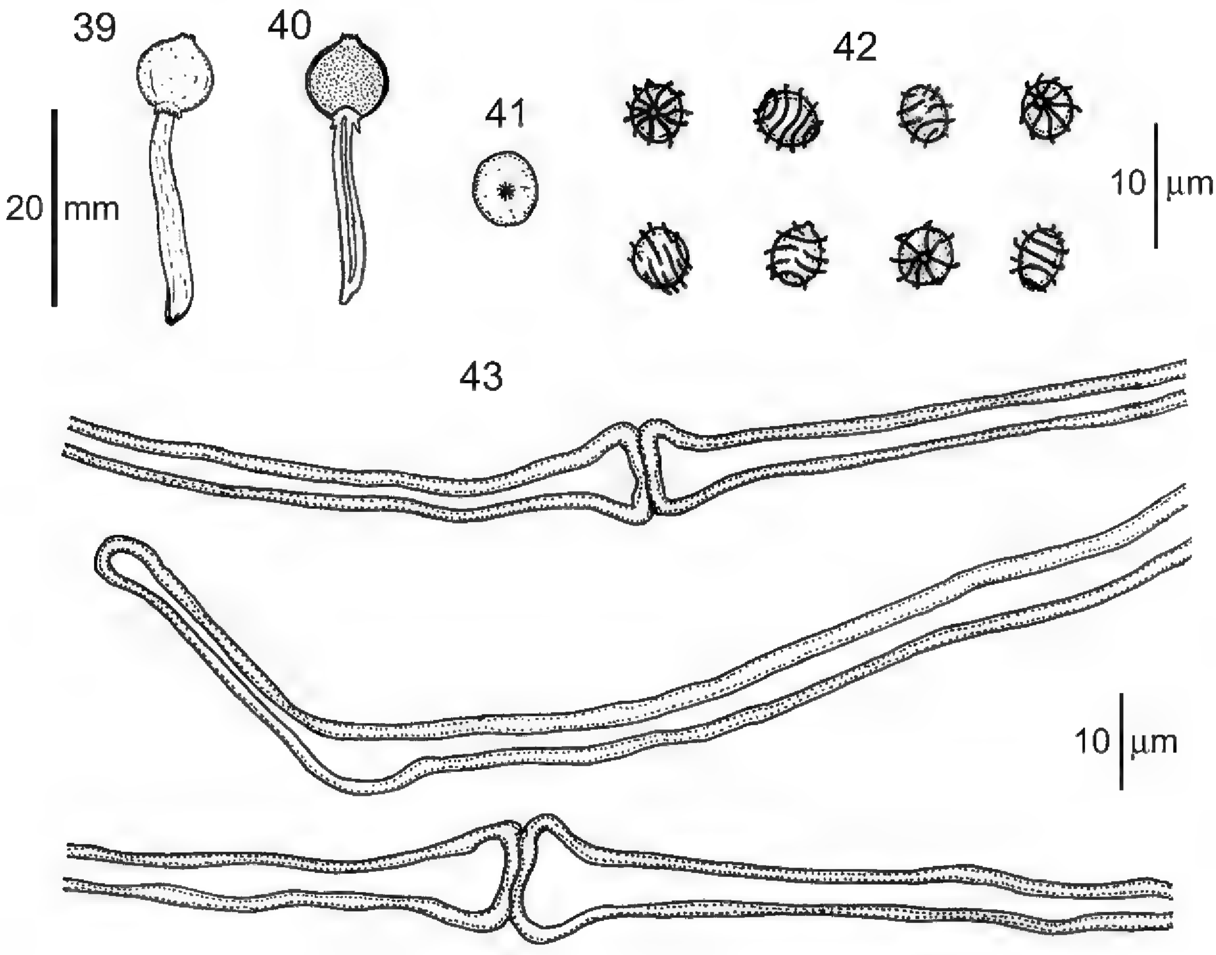

Fig. 39–43. *Tulostoma striatum*.
39. Basidioma. 40. Section of basidioma. 41. Top view of spore sac.
42. Basidiospores. 43. Capillitium.

membranous, with an almost smooth to slightly granulose surface, color dark blond (5D4) to grayish brown (5D3). Mouth definite, mammose, fibrillose to lacerated, slightly projecting, color indistinct from the endoperidium. Socket conspicuous, separate from the stipe, forming a membranous collar around the stipe apex, usually covered with sand. Gleba little pulverulent when mature, light brown (5D6). Stipe 15–22 × 3 mm, subcylindrical to clavate, slightly incurved, with an expanded base without visible rhizomorphs, surface smooth to rugulose or squamulose, color light orange (5A4) to grayish orange (5B4), fistulose, with white context.

Basidiospores 5.5–8.4 × 5–7.2 µm diam. (including ornamentation), subglobose to ovoid, yellowish brown in KOH, with a shortly-tubulose apiculus, striate ornamentation under light microscope; under SEM the ornamentation is conspicuously striate over a smooth surface. Capillitium 3.5–7.5 µm diam. hyphae, with subhyaline to stramineous and thick walls, sometimes presenting a granular and hyaline incrustation, lumen usually is reduced, septa and rare branches are present. Exoperidium and endoperidium little differentiated from the hyphae of the capillitium.

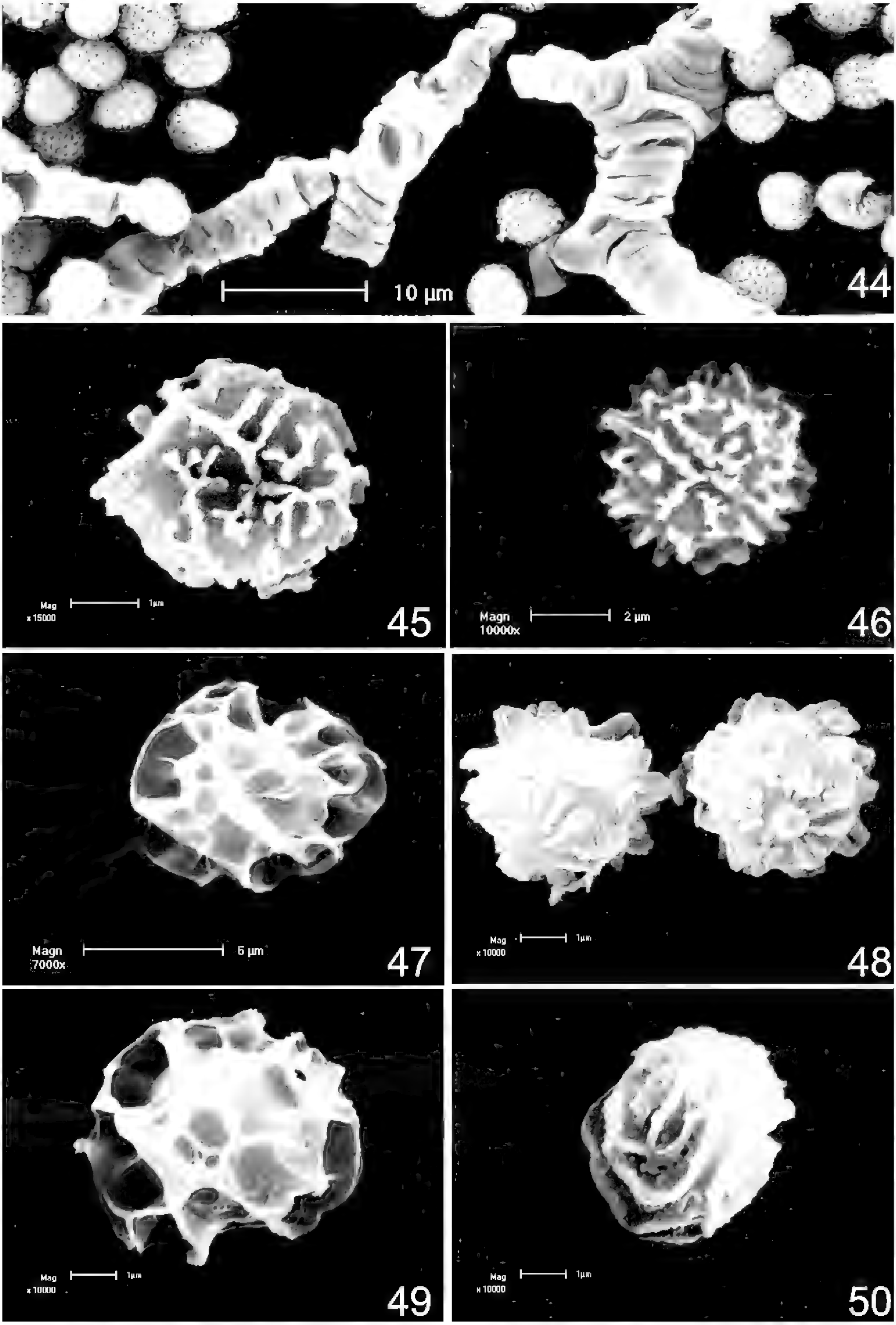

Fig. 44–50. SEM images of basidiospores and elaters.
44. *Battarrea phalloides* (basidiospores and elaters) . 45. *Tulostoma cyclophorum.* 46. *T. dumeticola.* 47. *T. exasperatum.* 48. *T. pygmaeum.* 49. *T. rickii.* 50. *T. striatum.*

Examined specimens: BRAZIL. Rio Grande do Sul State. **Balneário Pinhal:** IX.1961, *E.C. Vianna* (BAFC 51653, ICN 3560). **São Leopoldo:** 1930, *J. Rick* (PACA 15082).

Distribution: Widespread in Africa, Australasia, South, Central (Wright 1987) and North America (Oliver & Hosford 1979), and Europe (Altés & Moreno 1991). Brazil: only known in Rio Grande do Sul (Wright 1987).

Discussion: *Tulostoma striatum* is one of the most remarkable species in the genus because of the basidiospore ornamentation and for growing on sand or sandy places. *Tulostoma nigeriense* J.E. Wright presents similar basidiospores, but it differs in having a distinctive tubular mouth (Wright 1987).

Excluded or doubtful records

T. caespitosum Trab. – The material in Rick's collection (PACA 15068, as *T. mammosum*) was identified as 'cfr. *T. caespitosum*' by Dr. Jorge E. Wright, in 1972. Both macro- and microscopic features of the species (Wright 1987) are present in Rick's material and for this reason we consider it to be *T. caespitosum*. In view of the lack of any indication of its origin, we consider it a doubtful record, although we suspect it was probably collected by Rick in Rio Grande do Sul.

T. mammosum Fr. – This name is currently accepted as a synonym of *T. brumale* Pers. As far we know, the studied material in Rick's collection was never published. Part of his material is actually *T. caespitosum* (as discussed above), while another collection (BRAZIL. Rio Grande do Sul State: São Leopoldo, 1932, *J. Rick,* PACA 15077) consists of an unopened specimen of *Geastrum*.

T. rufum Lloyd – Reported by Rick (1930, 1961), but without reference to Brazilian specimens. This species is known in North America, Europe, and Africa (Wright 1987) and was only recently reported from northeastern Brazil by Silva et al. (2007a). Rick merely cited the species because he hypothesized that it could occur in south Brazil, although he had never collected it.

Acknowledgments

The authors thank the staff of the above-cited herbaria for loan of specimens. CNPq (Brazil) is acknowledged for financial support. Dr. Gabriel Moreno (Unversidad de Alcalá de Henares, Spain) and Dr. Maria Martha Dios (Universidad Nacional de Catamarca, Argentina) are thanked for critically reviewing this paper.

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The genera *Leucoagaricus* and *Leucocoprinus* (*Agaricales, Basidiomycota*) in Kerala State, India

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Abstract — Nine *Leucoagaricus* and fifteen *Leucocoprinus* species are recorded from Kerala State, India, including six new *Leucoagaricus* species (*Leucoagaricus crystalliferoides, L. subflavus, L. rufosquamulosus, L. candicans, L. luteosquamulosus, L. majusculus*) and four new *Leucocoprinus* species (*Leucocoprinus acutoumbonatus, L. delicatulus, L. munnarensis, L. pusillus*). A neotype from Kerala is designated for *Lepiota viridiflava,* rediscovered after nine decades and for which the new combination, *Leucoagaricus viridiflavus,* is proposed. A key to the *Leucoagaricus* and *Leucocoprinus* species collected during this study from Kerala is given and some taxonomic observations on the group are provided.

Key words — *Agaricaceae*, floristics, lepiotaceous fungi, taxonomy

Introduction

Traditionally, pale-spored species of the family *Agaricaceae* possessing spores that are metachromatic in cresyl blue and mostly lacking clamp connections have been referred to either *Leucoagaricus* Locq. ex Singer or *Leucocoprinus* Pat. Of these, species with more or less fragile, coprinoid basidiomata with plicate-striate pileal margin and well developed pseudoparaphyses in the hymenium are placed in *Leucocoprinus* while those producing sturdier basidiomata with non-striate pilei and lacking pseudoparaphyses are referred to *Leucoagaricus*. *Macrolepiota* Singer, another pale-spored genus that with *Leucoagaricus* and *Leucocoprinus* is characterized by metachromatic spores, differs in producing generally larger and more robust basidiomata with plentiful clamp connections. *Macrolepiota* species are also characterized by a complex mobile annulus and a well-developed collarium (Franco-Molano 1999). Heinemann (1969) distinguished *Macrolepiota* from *Leucoagaricus* based on the simpler spore-wall structure and reduced germ-pore development in *Leucoagaricus*.

Although *Leucoagaricus* and *Leucocoprinus* are widely accepted as two morphologically distinct genera, several species could belong to either genus. For example, several species belonging to the 'rubentes group' of Babos (1979) or the 'badhamii complex' of Reid (1990) have been transferred back and forth (compare Babos 1979, Moser 1983, Reid 1990, and Wasser 1993 with Candusso & Lanzoni 1990, Bon 1996, and Vellinga 2001b) between the rather nebulous generic boundaries of *Leucoagaricus* and *Leucocoprinus* (Vellinga 2004b, Kumar & Manimohan 2004, Vellinga & Davis 2006). Although the presence of pseudoparaphyses in the hymenium of *Leucocoprinus* species has been found to be a useful distinguishing character in such cases (Singer 1986, Kumar & Manimohan 2004), a recent molecular study (Vellinga 2004b) questions the validity of this character. Compared to *Leucocoprinus, Leucoagaricus* is an even more heterogeneous group intermediate between *Leucocoprinus* and *Macrolepiota*, incorporating several borderline species. It accommodates species with very small, fragile basidiomata, like those found in many *Leucocoprinus* species, as well as those resembling large, robust *Macrolepiota* species.

The enigmatic status of many species placed in both *Leucoagaricus* and *Leucocoprinus* continues despite preliminary DNA-based analyses meant to refine generic circumscriptions. Molecular phylogenetic studies (Vellinga 2004b), though only weakly supported, indicate that *Leucoagaricus* and *Leucocoprinus* together form a large monophyletic lineage. This lineage includes the polyphyletic genus *Sericeomyces* Heinem., composed of species with whitish colours and a cuticular pileal covering, which many authors (Candusso & Lanzoni 1990, Vellinga 2000) consider as only a subgenus of *Leucoagaricus*. Data from the aforesaid molecular study (Vellinga 2004b) indicate the feasibility of treating the resolved monophyletic *Leucoagaricus/Leucocoprinus* clade either as one large genus, or splitting it into distinct, monophyletic genera (Vellinga & Davis 2006). It seems that before a clear concept of the complex could be arrived at, more molecular data should be generated and analyzed with better representation of tropical species.

The genera *Leucoagaricus* and *Leucocoprinus* are thought to be highly diverse and common in the tropics (Vellinga 2004a). However, their documentation from the tropics has been inadequate. Results of a floristic study of these genera, carried out in Kerala State, India, are presented here. This study documents nine species of *Leucoagaricus* and fifteen species of *Leucocoprinus* from this region. Traditional taxonomic concepts of *Leucoagaricus* and *Leucocoprinus* have been followed in this morphology-based study and the new species described are treated accordingly.

One species of *Leucoagaricus* (*L. quilonensis* Sathe & J.T. Daniel) and eleven species of *Leucocoprinus* (*L. biornatus* (Berk. & Broome) Locq., *L. birnbaumii*, *L. brebissonii*, *L. bresadolae* (Schulzer) M.M. Moser, *L. cepistipes* (Sowerby) Pat.,

L. fragilissimus, *L. meleagris* (Sowerby) Locq., *L. squamulosus* (Mont.) Pegler, *L. venezuelanus*, *L. zeylanicus* (Berk.) Boedjin, *L. lacrymans*) have already been recorded from Kerala (Sathe & Daniel 1980, Vrinda et al. 1997, 2003; Kumar & Manimohan 2004).

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% aqueous KOH. Melzer's reagent, cresyl blue, and cotton blue were used to observe whether the spores were dextrinoid, metachromatic, and cyanophilic respectively. An average of 20 basidiospores per specimen was measured from spore prints or (when lacking) mature lamellae; standard deviation, Q (length/width) range, and Qm (average Q-value) were statistically derived for each species from a random selection of all spores measured. Colour codes refer to Kornerup & Wanscher (1978). Holotypes of all new taxa and additional and/or representative collections of all taxa documented here are deposited at Kew Herbarium and designated by their Kew (Mycology) accession numbers (e.g., K[M]158615). Unless otherwise indicated, all other examined collections cited are in the personal herbarium of the second author.

Taxonomic account

Key to the species of *Leucoagaricus* and *Leucocoprinus* of Kerala collected during this study

1a. Basidiomata more or less sturdy; pileus usually non-striate; pseudoparaphyses absent. . . . . .2 (*Leucoagaricus* species)

1b. Basidiomata mostly fragile; pileus radially striate; pseudoparaphyses well developed and abundant in the hymenium . . . . . 10 (*Leucocoprinus* species)

2a. Spores with a distinct germ-pore 4

2b. Spores lacking a germ-pore or with a rudimentary one 3

3a. Pileus usually red, brown, ochre, olive or orange pigmented; pileal covering a cutis of repent hyphae 6

3b. Pileus differently and lightly pigmented; pileal covering a disrupted cutis with ascending or erect terminal elements 9

4a. Basidiomata large; lamella-edge spotted dark brown; spores more than 10 μm long (10–15 × 7–9 μm); cheilocystidia and terminal elements of pileal covering with apical prolongation . . . . *L. majusculus*

4b. Basidiomata small to medium-sized; lamella-edge concolorous with the sides; spores less than 10 μm long; cheilocystidia and terminal elements of pileal covering without apical prolongation 5

5a. Basidiomata medium-sized; pileus whitish to light orange with brownish red squamules; annulus fixed and with a coloured rim; pileal elements without encrusting pigments; spores 6.5–9 × 4–5 µm . . . . ***L. rufosquamulosus***

5b. Basidiomata small; pileus whitish with brown to dark brown squamules; annulus movable and without a coloured rim; pileal elements with encrusting pigments; spores 5–10 × 3.5–5.5 µm . . . .***L. crystalliferoides***

6a. Pileus orange, brownish orange, brown or reddish brown 7

6b. Pileus pastel yellow or white 8

7a. Basidiomata small and somewhat delicate; pileal covering with two distinct layers; spores 6–8 × 3.5–4.5 µm . . . .***L. glabridiscus***

7b. Basidiomata small to medium-sized and rather robust; pileal covering single layered; spores 5–8 × 3.5–5 µm . . . . ***L. rubrotinctus***

8a. Basidiomata pastel yellow, turning olive to dark grey on bruising; cheilocystidia ventricose, utriform or broadly clavate with apical prolongation; spores 5.5–8.5 × 4–5 µm ... . ***L. viridiflavus***

8b. Basidiomata white, not turning olive to dark grey on bruising; cheilocystidia narrowly clavate to clavate, cylindrical, ellipsoid, obovoid or rarely utriform without apical prolongation; spores 5–6.5 × 3.5–4 µm . . . .***L. candicans***

9a. Pileus and context yellow; spores 4–7 × 2.5–3.5 µm, amygdaliform . . . . ***L. subflavus***

9b. Pileus and context white; spores 6–11 × 5–7.5 µm, ellipsoid, broadly ellipsoid, ovoid or globose. . . . .***L. luteosquamulosus***

10a. Spores with a conspicuous germ-pore 11

10b. Spores without a germ-pore or with a rudimentary one. 22

11a. Basidiomata turning greenish on reaction with ammonia .12

11b. Basidiomata not turning greenish on reaction with ammonia. 13

12a. Annulus persistent and with dense reddish brown squamules at the rim; cheilocystidia lageniform, utriform or broadly clavate with apical prolongation; pileal covering made of lageniform terminal elements with apical prolongation; spores 7–13 × 5–8 µm . . . .***L. holospilotus***

12b. Annulus evanescent, without any coloured squamules at the rim; cheilocystidia narrowly cylindric to flexuose without apical prolongation; pileal covering made of narrowly cylindrical to somewhat flexuose terminal elements; spores 5–13 × 4.5–11 µm . . . . ***L. lacrymans***

13a. Pileal covering with inflated, globose or subglobose elements. 14

13b. Pileal covering without inflated globose or subglobose elements 18

14a. Basidiomata extremely fragile, pastel yellow; spores 9.5–15 × 7–11 µm, often with an apical constriction . . . . ***L. fragilissimus***

14b. Basidiomata more or less sturdy, whitish, dull white, orange grey, or yellowish white; spores smaller and without apical constriction. 15

15a. Lamellae initially white, turning yellowish white, yellowish brown or orange grey; stipe changing colour on bruising 16

15b. Lamellae white to yellowish white; stipe not changing colour on bruising 17

16a. Basidiomata somewhat fragile; annulus inferior to almost central, with concolorous squamules; cheilocystidia inflated clavate to ovoid; spores 8–11 × 5.5–7 µm ... . *L. ianthinus*

16b. Basidiomata sturdy; annulus superior, with dark brown squamules on the upper side; cheilocystidia lageniform or utriform with apical appendages; spores 8–11 × 6–8 µm . . . .*L. acutoumbonatus*

17a. Pileus yellowish white with brown squamules; spores 9–13 × 6–9 µm . . . . *L. brebissonii*

17b. Pileus white to pinkish white with cinnamon, rust brown or reddish brown squamules; spores 6–10 × 4.5–6.5 µm . . . .*L. venezuelanus*

18a. Pileus whitish with dark brown, grey or dark grey squamules 19

18b. Pileus white or yellow with almost concolorous squamules 21

19a. Basidiomata somewhat fragile; stipe slender (1–2 mm wide); context colour remaining unchanged; spores 9–12 × 6–7 µm . . . . *L. delicatulus*

19b. Basidiomata not fragile; stipe rather robust (more than 2 mm wide); context whitish turning brown on exposure 20

20a. Pileus less than 20 mm in diameter; spores 7–10 × 5–6 µm, ovoid, ovo-ellipsoid, ellipsoid; pileal elements clavate, lageniform, cylindrico-clavate, utriform . . . . *L. pusillus*

20b. Pileus more than 20 mm in diameter; spores 8.5–12.5 × 6–8 µm, amygdaliform; pileal elements fusoid or cylindrical . . . . *L. munnarensis*

21a. Basidiomata white; stipe densely fibrillose to granular or wooly-floccose; spores 6–12 × 5–7 µm . . . . *L. cretaceus*

21b. Basidiomata yellow; stipe not densely fibrillose or wooly floccose; spores 8–11.5 × 5–7 µm . . . . *L. birnbaumii*

22a. Pileus non-striate; stipe turning rust brown to reddish brown on bruising; spores 5–9 × 3–4.5 µm, amygdaliform; cheilocystidia with apical prolongations; pileal covering with cylindrico-clavate elements . . . .*L. jubilaei*

22b. Pileus sulcate-striate; stipe colour unchanging; spores not amygdaliform; cheilocystidia without apical prolongations; pileal covering with ovoid, ellipsoid or globose elements 23

23a. Pileus with yellowish squamules; spores 5–10.5 × 3.5–6 µm; pileal covering with chains of ovoid, ellipsoid or globose cells terminated by short cylindrical elements . . . . *L. submontagnei*

23b. Pileus with dark brown squamules; spores 5–6.5 × 3.5–4.5 µm; pileal covering composed entirely of globose elements . . . .*L. straminellus*

Descriptions and comments on the species

Leucoagaricus majusculus T.K.A. Kumar & Manim., **sp. nov.** FIGURE 1
MYCOBANK MB512335

Pileus 80–85 mm latus, primo convexus, postea applanato expansus, albidus, squamulis brunneis obtectus. Lamellae liberae, albidae, confertae. Stipes 113–125 × 9–13 mm, albidus, vulnerato pallide brunneus, squamulis brunneis obtectus fibrillosus. Sporae 10–15 × 7–9 µm, ovoideae, ovo-ellipsoideae vel amygdaliformiae. Basidia 29–37 × 11–13 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 17–75 × 6–30 µm, versiforma, tenuitunicata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae fibulatae.

HOLOTYPE — **INDIA, KERALA STATE, Calicut District,** ARAYEDATHUPALAM: 19 August 2005, Arun Kumar AK384 (K[M]158586).

ETYMOLOGY: *majusculus* (Latin), somewhat large

BASIDIOMATA large. PILEUS 80–85 mm diam., convex when young, becoming applanate and finally concave with an upturned margin, with a low umbo; surface whitish with brown (7E8) to dark brown (7F8) fibrillose squamules radiating from the disc in broken concentric circles; disc pruinose to granular, finely striate towards the margin; margin initially incurved, becoming straight, eroded. LAMELLAE free, whitish, crowded, up to 7 mm wide, with lamellulae in 4–5 tiers; edge finely fimbriate to denticulate, with dark brown spots. STIPE 113–125 × 9–13 mm, central, terete, almost equal or expanding towards the base, fistulose; surface whitish with brown (7E8) squamules, turning light brown (5D5) on bruising and dark brown on drying, densely fibrillose to villose; base arising from a white mycelium. ANNULUS not observed. CONTEXT up to 3.5 mm thick, white. ODOUR not distinctive. SPORE-PRINT white.

SPORES 10–15 × 7–9 (11.7 ± 1.4 × 7.7 ± 0.77) µm, Q = 1.3–1.9, Qm = 1.5, ovoid, ellipsoid to broadly ellipsoid or rarely amygdaliform, hyaline, with a germ-pore up to 1 µm broad or often inconspicuous, with refractive guttules, thick-walled (up to 1.5 µm), smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 29–37 × 11–13 µm, clavate, with guttulate contents, hyaline, bearing 4 sterigmata up to 7.5 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA abundant, 17–75 × 6–30 µm, clavate, obovoid, utriform, or lageniform, mostly with apical prolongations up to 35 µm long, thin-walled, pale yellowish brown to dark grey. PLEUROCYSTIDIA none. LAMELLAR TRAMA subregular; hyphae 2–8 µm, inflated up to 29 µm wide, loosely attached, hyaline to pale grey, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–23 µm wide, cylindrical, septate, hyaline, thin- to slightly thick-walled, inamyloid. PILEAL COVERING mostly a cutis disrupted at the scales and towards the centre by trichodermial patches, entirely trichodermial at the disc; terminal elements 36–117 × 4–27 µm, clavate, utriform, or lageniform and mostly with one or more constrictions and having

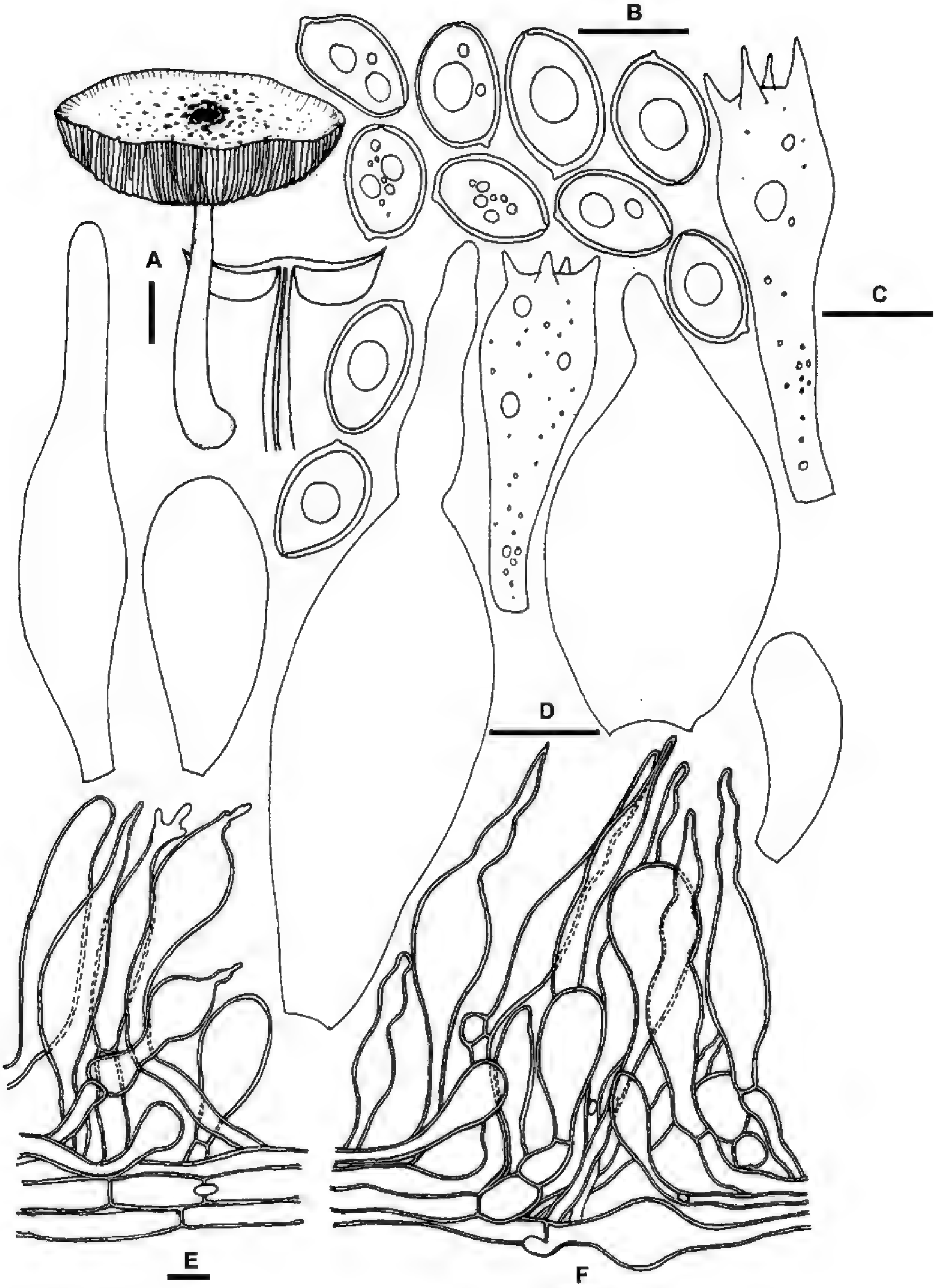

Figure 1. *Leucoagaricus majusculus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

apical prolongations which are usually flexuose or moniliform, thick-walled (up to 1 µm), with brown to dark brown membrane- and plasmatic pigments. Stipe covering a cutis of 5–40 µm wide, hyaline to pale brown, slightly thick- to thick-walled (up to 2µm) hyphae; terminal elements 26–108 × 10–28 µm, cystidioid, clavate, utriform, lageniform, ovoid, most with apical prolongation, thick-walled, with brown to dark brown plasmatic and membrane pigments. Clamp connections present on hyphae of pileus and stipe covering and very rarely at the base of cheilocystidia.

Habitat: On decomposing saw dust, solitary.

Comments: *Leucoagaricus majusculus* is distinguished by large and fleshy basidiomata, spores that are longer than 10 µm, and a trichodermial pileal covering with clavate, utriform, or lageniform terminal elements mostly having flexuose or moniliform apical prolongations. Owing to this unique combination of characters, this species does not exactly fit in descriptions of any of the known species. The overall nature of the basidiomata, large spores, cheilocystidia and terminal elements of veil with apical prolongations all indicate a relation with species of the 'badhamii complex' (Reid 1990) that have been placed in either *Leucocoprinus* or *Leucoagaricus,* although a colour reaction with ammonia, characteristic of the complex, was not observed. [Some complex species show varied ammonia reactivity (from strong to feeble or none, as with *Leucocoprinus jubilaei*); see Reid 1990.] Further, the relatively fleshy basidiomata, absence of distinct plicate pileus striations, and absence of hymenial pseudoparaphyses rule out a position inside *Leucocoprinus* and are suggestive of *Leucoagaricus*.

The large basidiome and spore sizes indicate affinities with the genus *Macrolepiota*. The clamp connections observed in *L. majusculus* also suggest similarities with *Macrolepiota*. Nonetheless, although clamp connections are not considered diagnostic of *Leucoagaricus*, they are observed infrequently in many *Leucoagaricus* species. For example, Didukh et al. (2003) records the presence of clamp connections in *Leucoagaricus wichanskyi* (Pilát) Bon & Boiffard, *L. carneifolius* (Gillet) Wasser, and *L. leucothites* (Vittad.) Wasser. Several other *Leucoagaricus* species from Kerala (recorded in this study) also possessed infrequent clamp connections. Despite the clamp connections observed in *L. majusculus*, other diagnostic *Macrolepiota* characters such as a collarium and complex-walled spores possessing a well developed germ-pore were found lacking. These observations favour placement of this species in *Leucoagaricus*.

Leucoagaricus majusculus exhibits close similarities with *Leucocoprinus holospilotus* and *L. meleagris* although the former evidently lacks well-developed pseudoparaphyses. *Leucocoprinus holospilotus* possesses a persistent annulus and smaller spores while *L. meleagris* differs mainly in having smaller

basidiomata and context that becomes bright red on bruising. *Leucoagaricus dextrinoidesporus* (Z. S. Bi) Zhu L. Yang seems to be another closely related species. However, compared to *Leucoagaricus dextrinoidesporus*, *L. majusculus* has larger basidiomata that lack a distinct umbo, lamellae that do not turn purple red when mature, a whitish stipe surface, larger basidiospores that are hyaline and not pale greenish yellow in KOH mounts, and clamp connections.

Leucoagaricus rufosquamulosus T.K.A. Kumar & Manim., **sp. nov.** FIGURE 2
MYCOBANK MB512336

Pileus 45 mm latus, primo convexus, applanato expansus, umbonatus, albidus vel pallide luteus, squamulis rufo-brunneis, ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 42 × 3.5 mm, albidus vel pallide luteus, vulnerato griseo aurantiacus, fibrillosus. Sporae 6.5–9 × 4–5 µm, oblongo-ellipsoideae, subcylindriceae vel amygdaliformiae. Basidia 10–17 × 7–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 16–40 × 7–15 µm, cylindricea, cylindrico-clavata vel utriformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

HOLOTYPE — INDIA, KERALA STATE, Wayanad District, MUTHANGA: 2 June 2005, Arun Kumar AK222 (K[M]158615).

ETYMOLOGY: *rufosquamulosus* (Latin), with red scales

BASIDIOMATA medium-sized. PILEUS 45 mm diam., initially convex, becoming broadly convex and finally applanate, with a broad umbo at the disc; surface whitish to light orange (6A4), with minute, brownish red (8C8), scattered, appressed-fibrillose squamules that are sparser towards the margin, pruinose to more or less smooth at the disc, finely striate at the margin; margin initially incurved, becoming straight, eroded. LAMELLAE free, whitish, crowded, up to 9 mm wide, with lamellulae in 3–4 tiers; edge fimbriate under a lens, concolorous with the sides. STIPE 42 × 3.5 mm, central, terete, equal, slightly bulbous at the base, initially solid, becoming fistulose with age; surface whitish to pale yellow (4A3), turning greyish orange (5B4) on bruising or with age, fibrillose; base arising from a white mycelium. ANNULUS superior, membranous, simple, ascending, fixed, with a rim covered with brownish red (8C8) fibrils. CONTEXT up to 1.5 mm thick, white. ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 6.5–9 × 4–5 (7.8 ± 0.63 × 4 ± 0.44) µm, Q = 1.5–2.25, Qm = 2, oblong-ellipsoid, subcylindrical, amygdaliform, or more or less fusiform with a slight suprahilar depression, often with a germ-pore 0.5 to 1 µm broad and covered with an indistinct hyaline cap, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 10–17 × 7–8 µm, almost ovoid to short clavate, hyaline, bearing 4 short sterigmata up to 2 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 16–40 × 7–15 µm, cylindrical, cylindrico-clavate, clavate, broadly

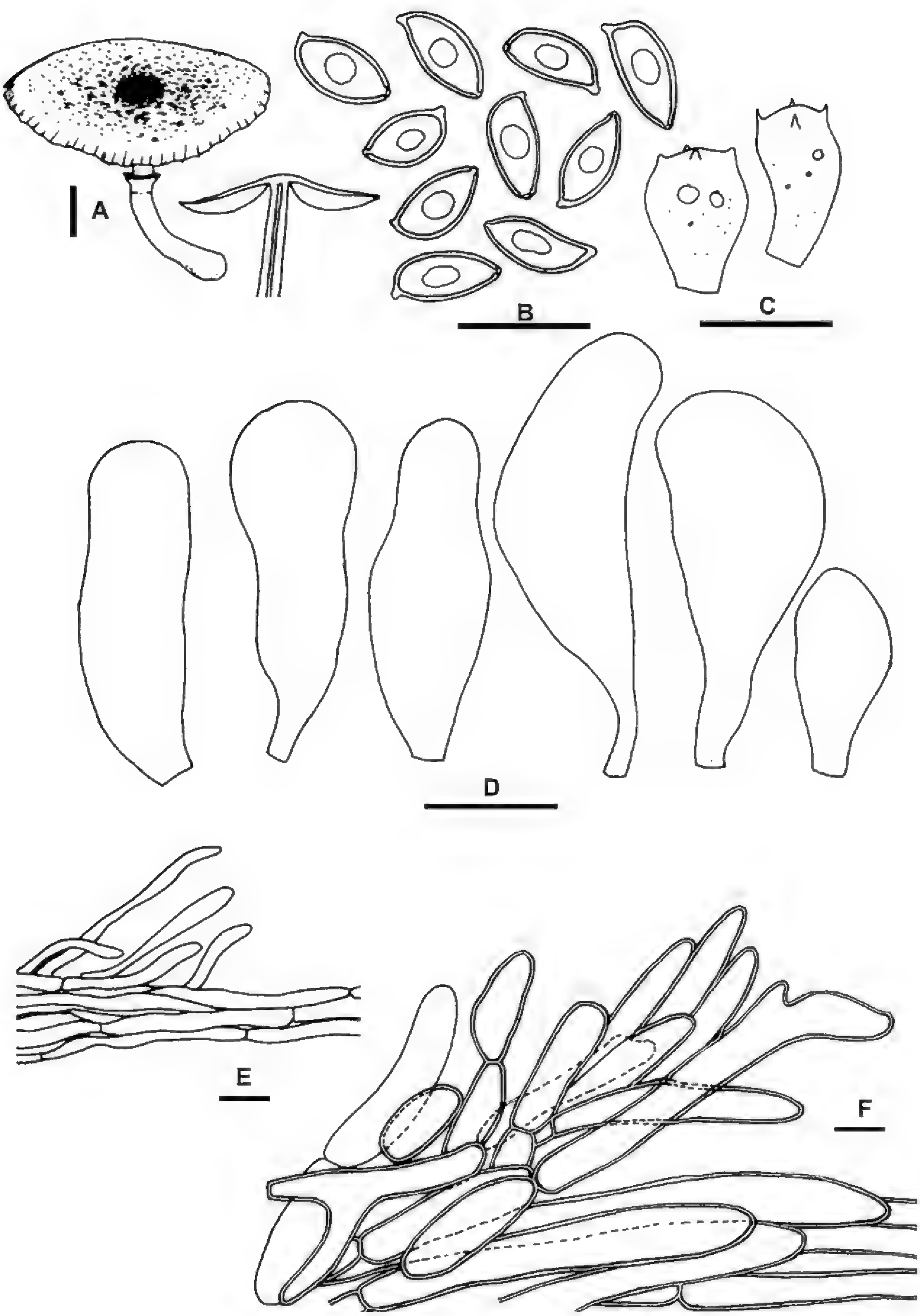

Figure 2. *Leucoagaricus rufosquamulosus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

clavate, or utriform, thin-walled, hyaline. Pleurocystidia absent. Lamellar trama subregular; hyphae 5–13 µm wide, inflated, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. Pileal covering a cutis of repent cylindrical hyphae disrupted by trichodermial patches of ascending or erect, loosely attached terminal elements; terminal elements 20–110 × 5–18 µm, cylindrical, cylindrico-clavate or ellipsoid, slightly thick- to thick-walled (up to 1 µm), with pale brown to brown plasmatic and membrane pigments. Stipe covering a cutis of repent hyphae with occasionally ascending hyphal filaments; hyphae 2–8 µm wide, thin-walled, hyaline. Clamp connections not observed.

Habitat: On soil, solitary.

Comments: *Leucoagaricus rufosquamulosus* is characterized by a pileus with brownish red squamules on a whitish to light orange background; oblong-ellipsoid, subcylindrical or amygdaliform spores with germ-pore covered by an indistinct hyaline cap; versiform cheilocystidia; and a pileal covering with loosely attached cylindrical, cylindrico-clavate or ellipsoid terminal elements. Since pseudoparaphyses were not observed in the hymenium, this species is referred to *Leucoagaricus*. Except for the persistent annulus, spores with germ-pore, short basidia, versiform cheilocystidia, and the lack of any encrusting pigments on the terminal elements on pileal covering, it is similar to *Leucoagaricus tener* (P.D. Orton) Bon.

Leucoagaricus crystalliferoides T.K.A. Kumar & Manim., **sp. nov.** Figure 3

MycoBank MB512337

Pileus 9–19 mm latus, primo convexus, postea applanatus, umbonatus, albidus, squamulis brunneis vel atrobrunneis obtectus. Lamellae liberae, primo albidae, postea brunneae, confertae. Stipes 25–38 × 1–2 mm, albidus, vulnerato brunneus. Sporae 5–10 × 3.5–5.5 µm, ellipsoideae, ovo-ellipsoideae, ovoideae, vel amygdaliformiae, poro germinativo instructae. Basidia 13–24 × 8–10 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 10–75 × 7–12 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae raro fibulatae.

Holotype — INDIA, Kerala State, Malappuram District, Calicut University Campus: 26 June 2006, Arun Kumar AK398 (K[M]158614).

Etymology: *crystalliferoides* (Latin), similar to (*Leucoagaricus) crystallifer*

Basidiomata small. Pileus 9–19 mm diam., initially convex, becoming broadly convex to applanate, finally turning slightly depressed, with a low or sometimes prominent umbo; surface whitish to dull white, dotted with minute, brown (7E5, 7E6) to reddish brown (8E8) or dark brown (7F7, 8F8), appressed-fibrillose squamules, pruinose to more or less smooth towards the disc; margin

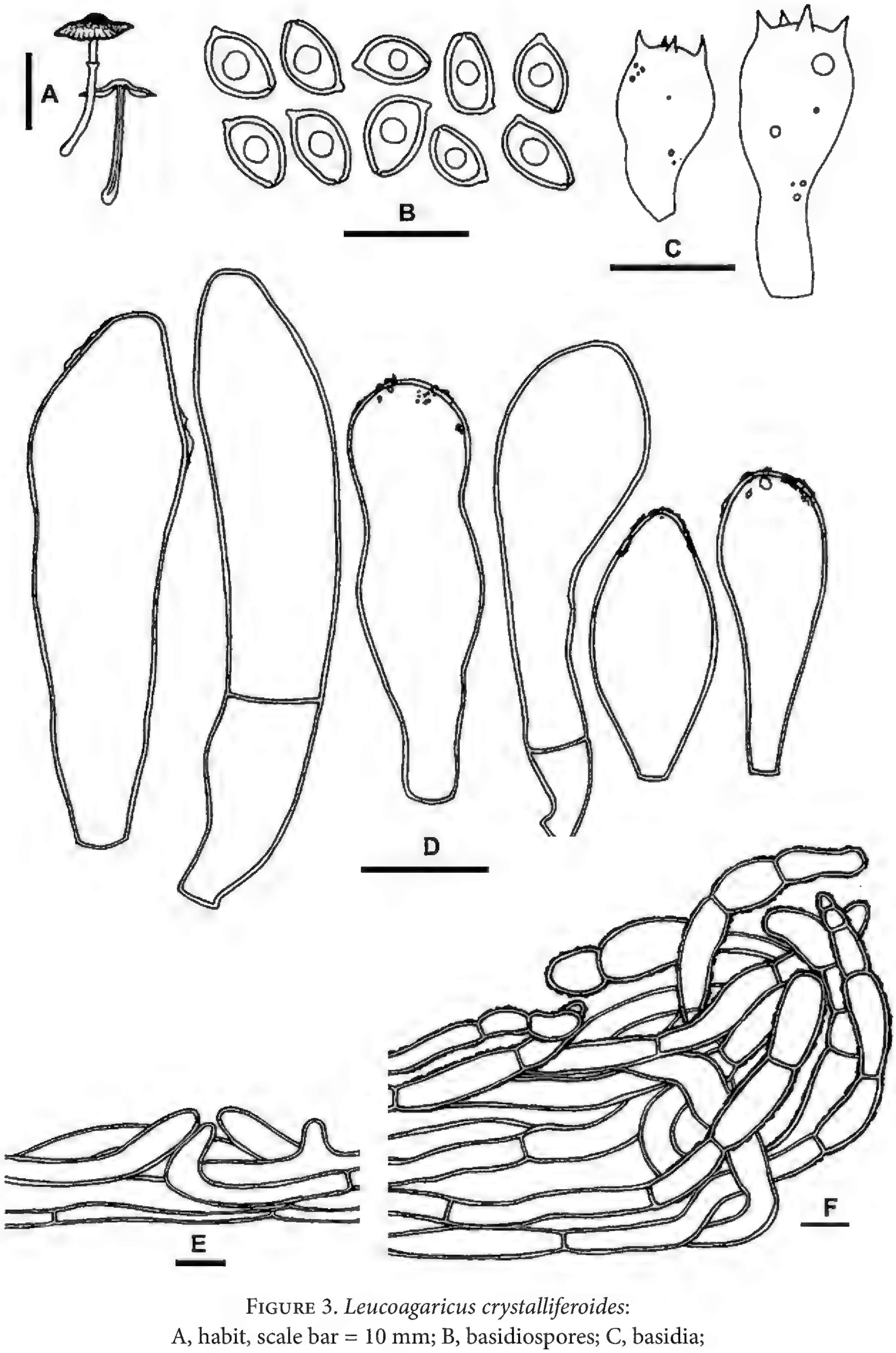

Figure 3. *Leucoagaricus crystalliferoides*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

initially incurved, later becoming straight, entire. LAMELLAE free, initially whitish, slowly turning yellowish white (2A2) to light brown (6D7) and finally brown (7E5) on bruising, drying or with age, moderately crowded to crowded, up to 2 mm wide, with lamellulae in 2–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 25–38 × 1–2 mm, central, terete, equal, slightly bulbous at the base, initially solid, becoming fistulose; surface whitish, turning light brown (6D7) to brown (7E5) on bruising or on drying, almost glabrous or slightly fibrillose; base arising from a white mycelium. ANNULUS almost central or superior, membranous, simple, ascending, movable, evanescent. CONTEXT up to 1 mm thick, whitish, changing to light brown (6D7), and gradually brown (7E5) on exposure. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5–10 × 3.5–5.5 (6.7 ± 0.89 × 4 ± 0.54) µm, Q = 1.3–1.8, Qm = 1.5, ellipsoid, ovo-ellipsoid, ovoid or amygdaliform, with an inconspicuous or distinct germ-pore up to 1 µm broad, hyaline, with refractive guttules, somewhat thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 13–24 × 8–10 µm, clavate to broadly clavate, hyaline, bearing 4 sterigmata up to 5 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 10–75 × 7–12 µm, cylindric, cylindrico-clavate, clavate, broadly clavate, utriform, ventricose, fusoid, broadly fusoid, or rarely strangulated, mostly septate, thin- to thick-walled (up to 1 µm), with fine guttulate contents and often with fine granular exudates on the surface, hyaline. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–25 µm wide, inflated, hyaline, thin- to slightly thick-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 3–40 µm wide, inflated, hyaline, thin-walled, inamyloid. PILEAL COVERING a repent cutis composed of 3–10 µm wide, slightly thick- to thick-walled (up to 1 µm) hyphae towards the margin, highly disrupted towards the centre and forming a trichodermium at the disc with ascending or erect terminal cells; terminal cells short, ellipsoid to cylindrical, 3–12 µm wide, thick-walled (up to 1 µm), with brown to dark brown plasmatic, membrane-, and encrusting pigments. STIPE COVERING a cutis of repent hyphae with occasional ascending hyphae; hyphae 3–10 µm wide, thin- to slightly thick-walled, with hyaline to pale brownish plasmatic pigment. Clamp connections rare, observed on hyphae of pileal covering.

HABITAT: On soil, solitary.

ADDITIONAL COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 10 July 2006, Arun Kumar *AK415;* 26 September 2006, Arun Kumar *AK443* (*K(M)158618*); 27 September 2006, Arun Kumar *AK448*.

COMMENTS: Distinctive characters of this rather small species are a whitish pileus with brown fibrillose squamules, lamellae and stipe that turn light

brown to brown on bruising, ellipsoid spores with a germ-pore, thick-walled cheilocystidia with fine granular exudates, and a cutis-type pileal covering that becomes trichodermial towards the disc with ascending or erect short ellipsoid to cylindrical terminal elements having plasmatic, membrane-, and encrusting pigments. Another remarkable observation is the rare occurrence of clamp connections, which are regarded as uncharacteristic of *Leucoagaricus*. However, spores of *Leucoagaricus crystalliferoides* do possess a noticeable germ-pore and exhibit a typical metachromatic reaction with cresyl blue, typical characters for the genus. *Leucoagaricus crystallifer* Vellinga, which appears to exhibit somewhat similar characters (Vellinga 2000, 2001b), differs in producing slightly larger basidiomata, apically papillate spores lacking a germ-pore, and pileal elements with different terminal cells. The ellipsoid spores with germ-pore in *L. crystalliferoides* differentiate it from other similar species such as *L. sericifer* (Locq.) Vellinga and *L. sublittoralis* (Kühner ex Hora) Singer.

Leucoagaricus glabridiscus (Sundb.) Wuilb., Doc. Mycol. 17(65): 46 (1986)

Collections examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 13 April 2005, Arun Kumar *AK212*; 15 April 2005, Arun Kumar *AK212a*; 3 June 2005, Arun Kumar *AK212b* (*K(M)158609*); 8 June 2005, Arun Kumar *AK212c*; 27 June 2005, Arun Kumar *AK297* (*K(M)158612*).

Comments: Characters of these collections perfectly agree with the original description of the species from the Pacific coast of USA except for the density of the lamellulae (5–6 tiers in the Kerala collections versus only 1–2 tiers in the USA material), slightly shorter spores (up to 10.3 µm in USA collections versus only up to 8 µm in Kerala collections), and the very rarely observed clamp connections. *Leucoagaricus glabridiscus* differs from the closely related *L. rubrotinctus* in its rather frail stature, smaller size, and double layered pileal covering of interwoven hyphae.

Leucoagaricus rubrotinctus (Peck) Singer, Sydowia 2: 36 (1948)

Collections examined — **INDIA, Kerala State, Calicut District,** Puthiyangadi: 10 April 2005, Arun Kumar *AK208*; **Malappuram District,** Calicut University Campus: 29 June 2005, Arun Kumar *AK323* (*K(M)158597*); 30 June 2005, Arun Kumar *AK323a*; 8 July 2005, Arun Kumar *AK345* (*K(M)158598*).

Comments: The present collections have characters that agree well with the published descriptions of *Leucoagaricus rubrotinctus*. This ubiquitous species is easily recognized in the field by its shades of pale orange to reddish orange or reddish brown colours of the pileal covering. Murrill (1912) differentiated this species from the closely similar *Lepiota rubrotinctoides* Murrill based on its'larger size, darker umbo, smaller spores, and the absence of scales on the surface of the pileus.'

Leucoagaricus viridiflavus (Petch) T.K.A. Kumar & Manim., **comb. nov.**

MycoBank MB512345 Figure 4

Basionym: *Lepiota viridiflava* Petch, Annals of the Royal Botanic Garden, Peradeniya 6: 195 (1917).

Neotype, here designated: INDIA, Kerala State, Malappuram District, Calicut university campus: *K(M)158611* (Arun Kumar *AK80*), 23 July 2004.

Basidiomata small, all parts readily turning olive (1E4, 1E5) to dark olive (2F8) and finally dark grey (1F1) on bruising. Pileus 11–29 mm diam., conico-convex when young, becoming convex to applanate with age, somewhat broadly umbonate; surface pastel yellow (1A4, 1A5), glabrous or rarely with minute appressed concolorous or olive (1E4, 1E5) fibrils, non-striate; margin initially incurved, becoming straight, entire or sometimes with velar remnants, becoming fissile with age. Lamellae free, moderately crowded to crowded, up to 4 mm wide, pastel yellow (1A4, 1A5) to greenish yellow (1A7), with lamellulae in 2–4 tiers; edge finely fimbriate under a lens, greenish in older specimens. Stipe 40–70 × 2–4 mm, central, terete, almost equal and with a slightly bulbous base (up to 6mm wide), initially solid, becoming fistulose with age; surface pastel yellow (1A4, 1A5, 2A4), smooth, fibrillose towards base. Annulus superior, membranous, evanescent. Context up to 4 mm thick at the disc, pastel yellow (1A3), changing olive (1E5, 1E6) to dark olive (2F8) on exposure. Odour not distinctive. Spore-print not obtained.

Spores 5.5–8.5 × 4–5 (6.9 ± 0.79 × 4.4 ± 0.64) µm, Q = 1.4–1.8, Qm =1.64, ovo-ellipsoid to subamygdaliform with a truncated apex, with an inconspicuous germ-pore, with a pale green tinge or almost hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 19–26 × 7.5–9 µm, clavate, with green vacuolar pigments, bearing 4 sterigmata up to 5 µm long. Lamella-edge sterile. Cheilocystidia crowded, 15–38 × 7–18 µm, utriform, ventricose or broadly clavate, thin-walled, mostly with an apical prolongation up to 16 µm long and 6 µm wide, often with amorphous contents and covered with similar exudates towards the apex, hyaline. Pleurocystidia absent. Lamellar trama subregular; hyphae inflated, septate, 2–20 µm wide, hyaline, thin-walled, inamyloid; Subhymenium cellular. Pileal trama parallel-interwoven; hyphae closely septate, inflated, 5–20 µm wide, hyaline to pale yellowish green, thin-walled, inamyloid, with obtuse tips. Pileal covering an undifferentiated cutis of repent, cylindric, septate, 3–12 µm wide, thin-walled, yellow or yellowish green to green pigmented hyphae. Stipe covering a cutis; hyphae 3–10 µm wide, thin-walled, with greenish plasmatic pigment. Clamp connections very rarely observed in the hyphae of the pileal trama.

Habitat: On soil, among decaying *Acacia* leaves, solitary or scattered.

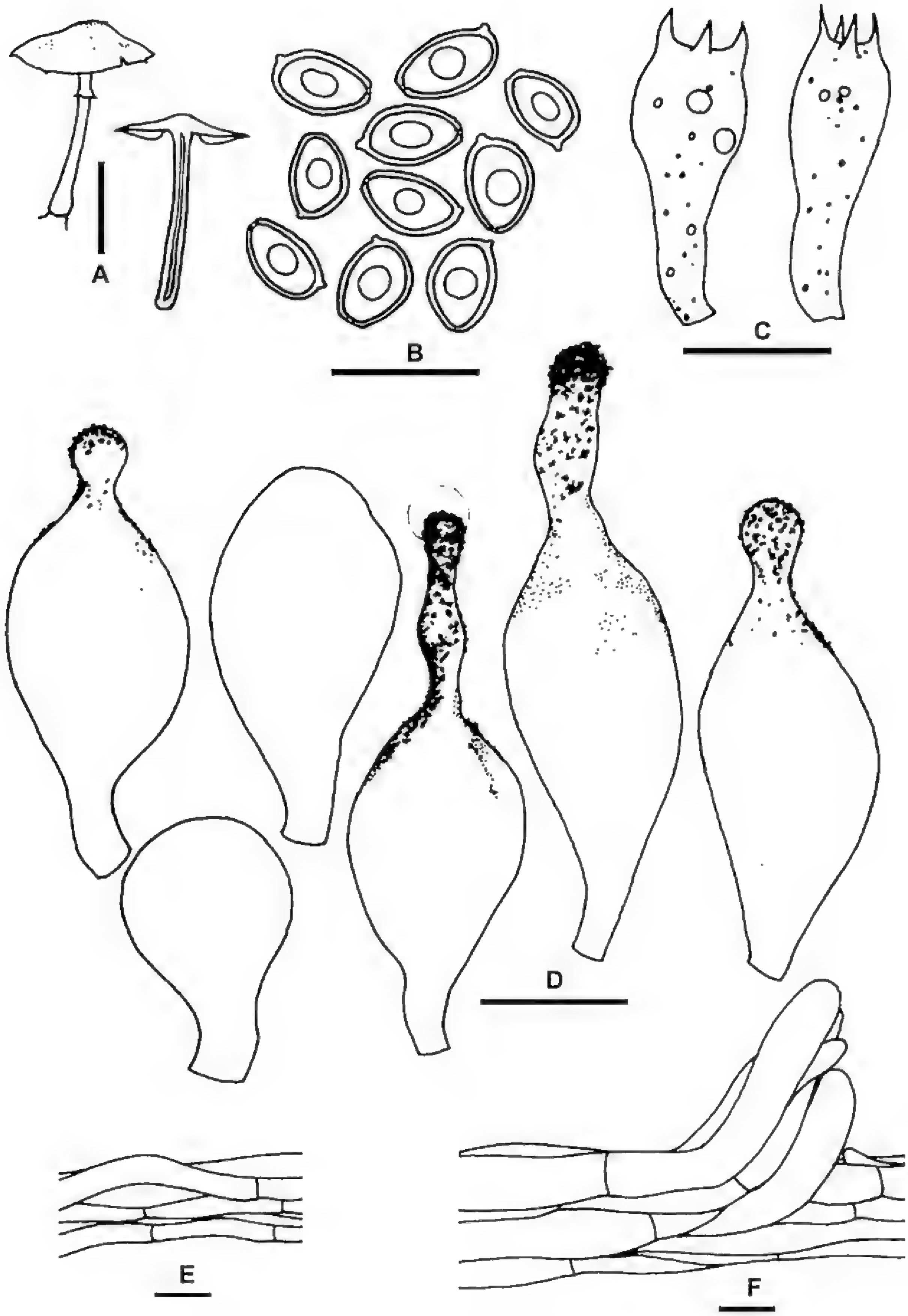

FIGURE 4. *Leucoagaricus viridiflavus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Other collections examined — **INDIA, Kerala State, Malappuram District,** Calicut university campus: 3 June 2004, Arun Kumar *AK45*; 4 June 2004, Arun Kumar *AK47*; 4 June 2004, Arun Kumar *AK45a*; 8 June 2004, Arun Kumar *AK45b*; 9 June 2004, Arun Kumar *AK52*; 7 October 2004, Arun Kumar *AK 128* (*K(M)158610*); 10 November 2004, Arun Kumar *AK185*; 10 November 2004, Arun Kumar *AK80a*.

Comments: *Leucoagaricus viridiflavus* fruits widely and regularly in the Calicut University campus and adjoining areas around *Acacia* trees during dry spells immediately after heavy rains. It has not been encountered so far from other parts of the State.

This species is remarkable for the olive green colouration that develops on all parts of the basidiomata upon bruising. It is further characterized by its yellowish colour, nearly smooth pileus, non-striate, occasionally velate pileal margin, subbulbous stipe base, and evanescent annulus. The metachromatic, ovo-ellipsoid to subamygdaliform spores with truncate apex and inconspicuous germ-pore and versiform cheilocystidia with long apical prolongations ornamented with amorphous encrustations are also characteristic of this species.

The present collections exhibit all character states cited by Petch (1917) in the original description of *Lepiota viridiflava* based on material from Sri Lanka. Petch, however, gave only a scanty description of this species and the only microscopic data provided were on the size and shape of the spores. Microscopical examinations of the present collections show spores that possess a difficult to distinguish, inconspicuous germ-pore and an inner wall layer that is metachromatically reactive in cresyl blue. The cheilocystidia have apical prolongations that are found in many *Leucoagaricus* and *Leucocoprinus* species. Except for the extremely rarely observed clamp connections, these specific characters favour a position inside the *Leucoagaricus*/*Leucocoprinus* complex, in contrast to its current placement in the genus *Lepiota*. Owing to the somewhat robust nature of the basidiomata, the lack of distinct striations on the pileus and the absence of pseudoparaphyses in the hymenium, this species is treated under *Leucoagaricus* in this study.

In his original description of this species, Petch (1917) did not cite any type material. Stating that no material for this species could be traced for examination, Pegler (1972, 1986) entirely reproduced Petch's original account of the species in his accounts of agarics of Sri Lanka, 'for the sake of completeness.' Recently, Akers et al. (2000) described a new species (*Leucoagaricus viridiflavoides* B.P. Akers & Angels) from Florida and discussed its affinities to related taxa including *Lepiota viridiflava,* noting the inability to locate any available representative collections of *L. viridiflava* in herbaria. A thorough literature search also indicates that the species has not been collected from either its type locality or anywhere else since its original discovery. As the holotype for

L. viridiflava appears to be lost, collection K(M)158611 from Kerala is proposed here as neotype for this species.

Leucoagaricus viridiflavoides and *L. sulphurellus* (Pegler) B.P. Akers are two closely related species characterized by yellow flesh that bruises bluish green. The Akers et al. (2000) study of the *L. sulphurellus* holotype showed it to be distinct from *L. viridiflavus*. *Leucoagaricus viridiflavoides* can be distinguished from *L. viridiflavus* based on spore size, presence of pleurocystidia, and shape of pileal covering elements.

Leucoagaricus candicans T.K.A. Kumar & Manim., **sp. nov.** FIGURE 5

MYCOBANK MB512338

Pileus 15–43 mm latus, primo companulatus, postea convexus, umbonatus, squamulosus, albus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 25–86 × 2–5 mm, albidus, vulnerato pallide luteus. Sporae 5–6.5 × 3.5–4 µm, ellipsoideae, ovoideae vel amygdaliformiae. Basidia 11–15 × 6–8 µm, clavata, 4- sporigera. Acies lamellarum sterilis. Cheilocystidia 19–42 × 11.5–17 µm,versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei ex hyphis repentibus composita. Hyphae raro fibulatae.

HOLOTYPE — INDIA, KERALA STATE, Malappuram District, CALICUT UNIVERSITY CAMPUS: 3 June 2005, Arun Kumar AK230 (K[M]158587).

ETYMOLOGY: *candicans* (Latin), white

BASIDIOMATA medium-sized. PILEUS 15–43 mm diam., initially campanulate with an umbo, becoming convex to broadly convex on maturity, distinctly umbonate at the disc; surface white, with concolorous or occasionally yellowish white (2A2), recurved, fibrillose squamules, striate towards margin; margin initially incurved, becoming straight, eroded. LAMELLAE free, whitish, crowded, up to 5 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 25–86 × 2–5 mm, central, terete, almost equal but slightly expanded towards base (up to 6 mm), initially fistulose becoming hollow with age; surface whitish, turning pale yellow (4A3) on bruising, almost glabrous; base arising from a white mycelium. ANNULUS superior or central, membranous, simple, ascending, fixed. CONTEXT up to 1 mm thick, whitish, changing to pale yellow (4A3) on exposure. ODOUR not distinctive. SPORE-PRINT white.

SPORES 5–6.5 × 3.5–4 (5.7 ± 0.44 × 4 ± 0.2) µm, Q = 1.3–1.7, Qm = 1.5, ellipsoid to ovoid or amygdaliform, without a germ-pore, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 11–15 × 6–8 µm, short clavate, hyaline, bearing 4 short sterigmata up to 2 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA crowded, 19–42 × 11.5–17 µm, narrowly clavate, clavate, cylindrical, ellipsoid, obovoid or rarely utriform, thin-walled, hyaline.

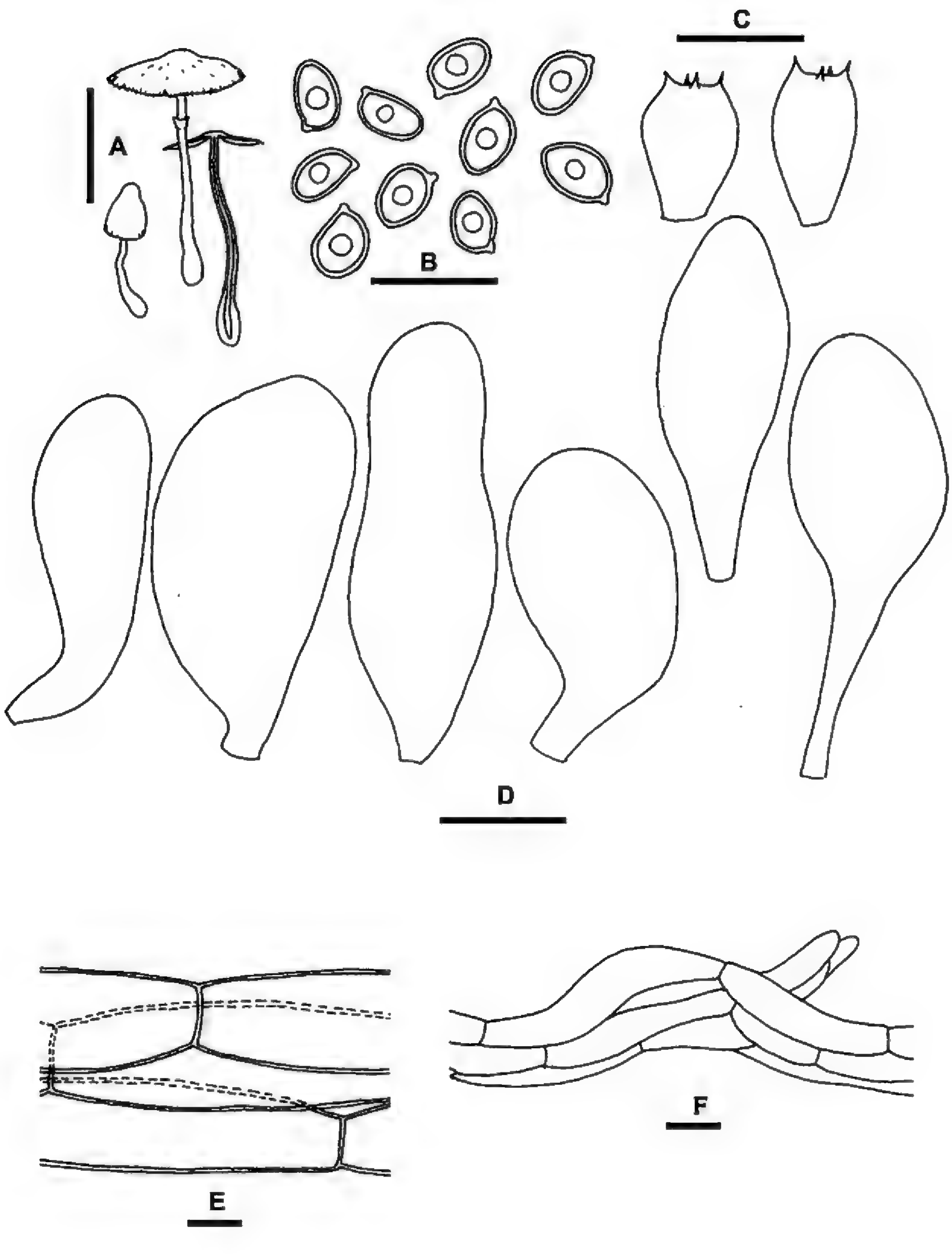

Figure 5. *Leucoagaricus candicans*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 μm.

Pleurocystidia absent. Lamellar trama subregular; hyphae 2–30 µm wide, inflated, branched, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pileal trama interwoven, composed of highly inflated, 3–40 µm wide, hyaline, thin-walled, inamyloid hyphae. Pileal covering a repent cutis of inflated, 2–25 µm wide, thin-walled hyaline hyphae with occasionally ascending terminal elements. Stipe covering a cutis of slightly inflated, thin- to slightly thick-walled, 3–34 µm wide, hyaline hyphae. Clamp connections rarely present on hyphae of the pileal covering.

Habitat: On soil, among decaying leaf litter, solitary or scattered.

Additional collection examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 6 June 2005, Arun Kumar *AK235* (*K(M)158588*).

Comments: This thin-fleshed species is diagnosed by a pure white pileus covered with almost concolorous squamules, a fixed annulus, ellipsoid to amygdaliform spores without a germ-pore, short clavate basidia, and a cutis-type pileal covering. *Leucoagaricus candicans* is assigned to *Leucoagaricus* because of the absence of distinct plicate/sulcate striations on the pileus and lack of hymenial pseudoparaphyses. *Leucoagaricus hortensis* (Murrill) Pegler (≡ *Chlorophyllum hortense* (Murrill) Vellinga), another white species, differs on account of its larger fleshy basidiomata whose stipe context shows strong reddening reaction when bruised, two-spored basidia, larger spores, and a subhymeniform pileal covering with clavate terminal elements.

Leucoagaricus subflavus T.K.A. Kumar & Manim., **sp. nov.** Figure 6

MycoBank MB512339

Pileus 10–22 mm latus, primo ovoideus, postea convexus et applanato expansus, uatus, luteus, squamulis luteis obtectus. Lamellae liberae, primo albae, postea pallide luteae, confertae. Stipes 14–30 × 1–3 mm, albidus. Sporae 4–7 × 2.5–3.5 µm, amygdaliformiae. Basidia 11–23 × 5–8 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 20–39 × 6.5–12 µm, cylindrico-clavata vel clavata.,Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

Holotype — INDIA, Kerala State, Malappuram District, Calicut University Campus: 4 October 2004, Arun Kumar AK116 (K[M]158613).

Etymology: *subflavus* (Latin), pale yellowish

Basidiomata small. Pileus 10–22 mm diam., ovoid when young, becoming convex to broadly convex and finally applanate, with an indistinct umbo; surface yellow (2A6), yellowish white (2A2) towards margin, with concolorous recurved squamules scattered except at the disc which remains smooth, sulcate-striate towards margin; cuticle peeling off as a layer at maturity or on ageing revealing the underlying context; margin initially incurved, becoming straight or upturned with age, entire to slightly crenate. Lamellae free, initially white,

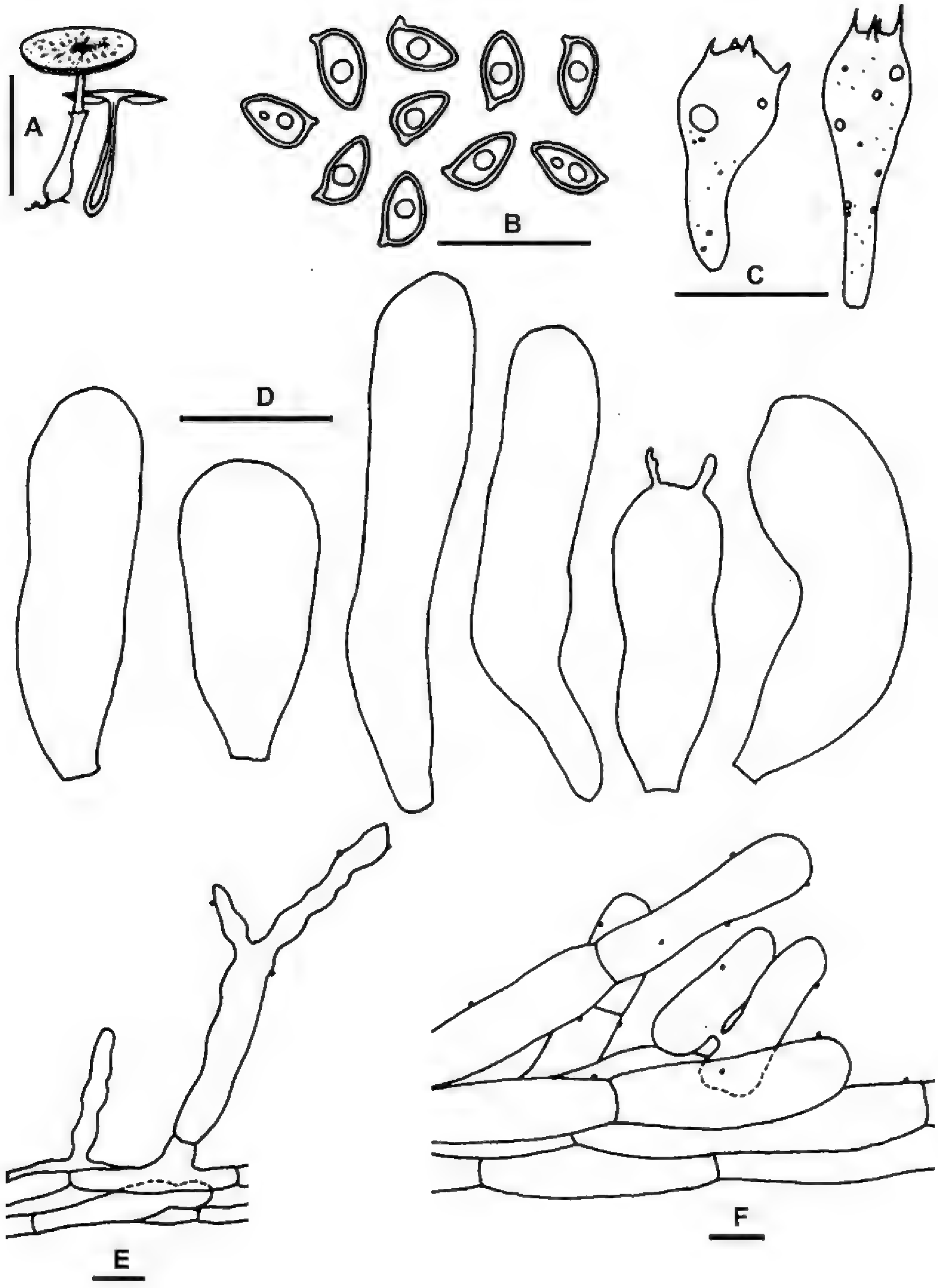

Figure 6. *Leucoagaricus subflavus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

becoming yellowish white (2A2), close to crowded, up to 4 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 14–30 × 1–3 mm (up to 6 mm wide at the base), central, terete, expanded towards the base, solid when young, becoming fistulose and finally hollow with age; surface whitish, fibrillose; base arising from a white mycelium. ANNULUS central, membranous, ascending, fixed. CONTEXT up to 1 mm thick, yellow (2A6). ODOUR not distinctive. SPORE-PRINT white.

SPORES 4–7 × 2.5–3.5 (5.5 ± 0.8 × 3 ± 0.2) µm, Q = 1.6–2.3, Qm = 1.9, amygdaliform, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, weakly metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 11–23 × 5–8 µm, clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 µm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA 20–39 × 6.5–12 µm, cylindrico-clavate to inflated clavate, rarely with 1–2 finger-like apical protrusions, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–18 µm wide, inflated, septate, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 2–25 µm wide, inflated, hyaline, thin-walled, inamyloid. PILEAL COVERING a cutis of loosely attached 3–25 µm wide, inflated hyphae, thin-walled, hyaline to pale yellow, occasionally disrupted by ascending, terminal elements; terminal elements 16–53 × 8–22 µm, cylindrical, thin-walled, with pale yellow plasmatic pigment. STIPE COVERING a cutis of 2–10 µm wide, hyaline, thin-walled hyphae with cylindrical or moniliform, at times branched elements often arising as lateral branches; terminal elements 21–90 × 4–9 µm, hyaline, thin-walled. All hyphae lack clamp connections.

HABITAT: On soil and on decaying leaf litter, solitary.

ADDITIONAL COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 5 October 2004, Arun Kumar *AK123* (*K(M)158589*); 15 October 2004, Arun Kumar *AK138*; 26 October 2004, Arun Kumar *AK150*; 1 November 2004, Arun Kumar *AK116a*.

COMMENTS: *Leucoagaricus subflavus* is characterized by a yellowish pileus with striations towards the margin, amygdaliform spores that are dextrinoid and weakly metachromatic in cresyl blue, cylindrico-clavate to inflated clavate cheilocystidia rarely having apical projections, a cutis-type pileal covering disrupted by ascending cylindrical terminal elements, a stipitipellis with branched, cylindrical or distinctly moniliform elements, and the absence of clamp connections. Although *L. subflavus* has weakly metachromatic spores, a combination of characters such as total absence of clamp connections and presence of cheilocystidia with apical extensions justify its placement in *Leucoagaricus* rather than in *Lepiota* sensu stricto. Placement in *Leucocoprinus* is also ruled out because of the lack of pseudoparaphyses in the hymenium. *Leucoagaricus serenus* (Fr.) Bon & Boiffard, a closely related species, differs in

being a predominantly white species with whitish context with larger spores and long pedicellate cheilocystidia. *Leucoagaricus sericifer* has basidiomata that turn brown on bruising, larger spores, and distinctly lageniform cheilocystidia with crystals at the apex.

Leucoagaricus luteosquamulosus T.K.A. Kumar & Manim., **sp. nov.** FIGURE 7

MYCOBANK MB512340

Pileus 10–15 mm latus, primo subglobosus, postea, applanato expansus, albus, squamulis minutis pallide luteis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albae, confertae. Stipes 15–34 × 1–2 mm, albus, fibrilloso-villosus. Sporae 6–11 × 5–7.5 μm, ellipsoideae, ovoideae vel subglobosae. Basidia 19–40 × 10–15 μm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 17–57 × 6–26 μm, versiformia, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

HOLOTYPE — **INDIA, KERALA STATE, Calicut District,** PUTHIYANGADI: 30 September 2004, Arun Kumar AK 111 (K[M]158585).

ETYMOLOGY: *luteosquamulosus* (Latin), with yellow scales

BASIDIOMATA small. PILEUS 10–15 mm diam., subglobose when young, becoming convex to broadly convex and finally applanate, with an indistinct umbo; surface white, with minute, recurved, pale yellow (3A3) to orange white (5A2) or brownish orange (5C4) squamules scattered throughout and concentrated towards the disc, canescent, distinctly sulcate-striate towards margin; margin initially incurved, later straight, crenate. LAMELLAE free, white, close to moderately crowded, up to 2 mm wide, with lamellulae in 2–3 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 15–34 × 1–2 mm (up to 5 mm wide at the base), central, terete, almost equal above the annulus, expanding towards base, initially solid, becoming fistulose; surface white, fibrillose-villose; base arising from white mycelial cords. ANNULUS central or superior, membranous, descending, fixed. CONTEXT less than 1 mm thick, white. ODOUR not distinctive. SPORE-PRINT white.

SPORES 6–11 × 5–7.5 (8.5 ± 1 × 6 ± 0.09) μm, Q = 1.1–1.8, Qm = 1.5, ellipsoid, broadly ellipsoid, ovoid, or subglobose, without a germ-pore, hyaline, with refractive guttules, somewhat thick-walled, smooth, dextrinoid, metachromatic in cresyl blue, cyanophilous in cotton blue. BASIDIA 19–40 × 10–15 μm, clavate to broadly clavate, with guttulate contents, bearing 4 sterigmata up to 5 μm long. LAMELLA-EDGE sterile with crowded cheilocystidia. CHEILOCYSTIDIA 17–57 × 6–26 μm, versiform: obovoid, oblong, ellipsoid, inflated-clavate, utriform or rarely cylindrical, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–30 μm wide, inflated, septate, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PILEAL TRAMA interwoven; hyphae 3–23 μm wide, inflated, hyaline, thin-walled, inamyloid. PILEAL COVERING a cutis of 5–12 μm wide, filamentous hyphae disrupted by ascending or erect patches of

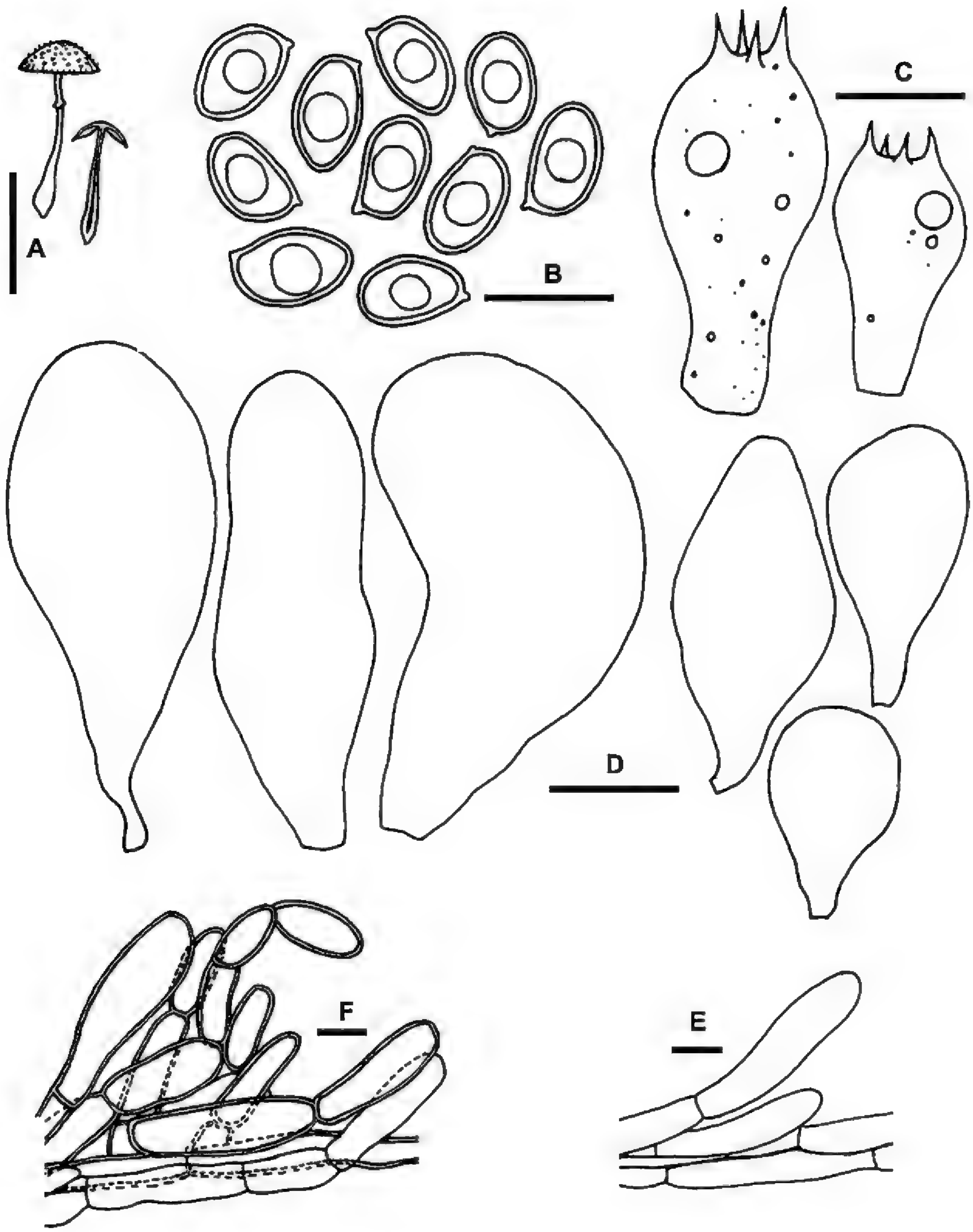

Figure 7. *Leucoagaricus luteosquamulosus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

hyphae with cylindrical or clavate terminal elements; terminal elements, 22–70 × 6–20 µm, hyaline to pale yellow, thin-walled. STIPE COVERING a disrupted cutis of 2–20 µm wide, hyaline to pale yellow, thin-walled, branched hyphae with cylindrico-clavate terminal elements. All hyphae lack clamp connections.

HABITAT: On soil and among decaying leaf litter, solitary or scattered.

ADDITIONAL COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Calicut District,** PUTHIYANGADI: 29 October 2003, Arun Kumar *AK10;* 14 October 2004, Arun Kumar *AK111a*; **Malappuram District**, CALICUT UNIVERSITY CAMPUS: 26 October 2004, Arun Kumar *AK153* (*K(M)158616*); 2 November 2004, Arun Kumar *AK153a*; Nilambur: 13 September 2004, Arun Kumar *AK97*; **Wayanad District**, MUTHANGA: 2 June 2005, Arun Kumar *AK 225*.

COMMENTS: Subglobose to broadly ellipsoid spores that are metachromatic in cresyl blue, obovoid, inflated-clavate, clavate or utriform cheilocystidia, and a pileal covering that is basically a cutis disrupted by ascending patches of loose hyphae with cylindrical, ellipsoid or clavate terminal elements are the distinguishing characters of *L. luteosquamulosus*. Spores that are metachromatic in cresyl blue and the absence of pseudoparaphyses place the species inside *Leucoagaricus*. The combination of characters observed in the present collections does not agree with that of any of the already known lepiotaceous species. Although *Leucoagaricus sericifer* and *L. serenus* are macroscopically similar to *L. luteosquamulosus* (ignoring its smaller basidiomata), micromorphological differences (e.g., spore shape and dimensions, cheilocystidial shape) separate *L. luteosquamulosus* from the other two species. *Leucoagaricus sericifer* is distinguished by a pileal margin lacking sulcate striations, narrower amygdaliform spores, and lageniform cheilocystidia. *Leucoagaricus serenus* has smaller amygdaliform spores and pedicellate-clavate cheilocystidia.

Leucocoprinus holospilotus (Berk. & Broome) D.A. Reid, Mycol. Res. 94: 648 (1990)

COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Malappuram District,** CALICUT UNIVERSITY CAMPUS: 10 July 2004, Arun Kumar *AK53*; 9 July 2004, Arun Kumar *AK65*; 29 June 2006, Arun Kumar *AK 404* (*K(M)158591*); 30 June 2006, Arun Kumar *AK405*; 10 July 2006, Arun Kumar *AK 416*; 11 July 2006, Arun Kumar *AK404a*; **Calicut District**, PAVANGAD: 12 June 2005, Arun Kumar *AK257*; Nallalam: 28 June 2006, Arun Kumar *AK402* (*K(M)158590*).

COMMENTS: Except for their slightly larger spore dimensions (7–13 × 5–8 µm), the Kerala collections agree with the description of *Leucocoprinus holospilotus* given by Pegler (1972, 1986, as *Lepiota holospilota*) based on the type materials of two species (Thwaites 1171 and Thwaites 1168, holotypes of *Agaricus holospilotus* and *A. biornatus*, respectively) originally described by Berkeley & Broome (1871) from Sri Lanka. Pegler justified synonymising *A. holospilotus* and *A. biornatus* because, except for the smaller basidiomata of the former, the two are identical in all macroscopic and microscopic characters. After study of

the type materials and the original diagnoses and illustrations of the two species, Reid (1990) accepted Pegler's synonymy but transferred *L. holospilotus* to *Leucocoprinus* with a remark that considerable confusion exists and that a study of more materials from Sri Lanka is required to establish the precise identity of the species. The present collections from Kerala displayed a continuous range of variations in both macroscopic and microscopic characters. In light of these observations, recognition of two species cannot be supported.

This species has earlier been reported from Kerala by Vrinda et al. (2003) as *Leucocoprinus biornatus* with descriptions almost identical with the present collections. A very close *L. caldariorum* D.A. Reid differs in having a well-developed spreading annulus, broadly amygdaliform spores, and hymeniform pileal surface layer topped with clavate to lanceolate elements. *Leucocoprinus meleagris* differs in having a context that reddens on exposure, an indistinct annulus, and cylindrical to clavate pileal covering elements. *Leucocoprinus bresadolae* could be differentiated based on its twisted and ribbon-like elongated pileal elements and by the lack of any differentiated elements on the stipe surface. However, there appears to be an overlap in range of characters among *L. holospilotus*, *L. caldariorum*, *L. meleagris,* and *L. bresadolae;* more morphological and molecular investigations are required for a better understanding of their taxonomic status and relationships.

Leucocoprinus lacrymans T.K.A. Kumar & Manim., Mycotaxon 90 (2): 393 (2004)

COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Calicut District,** PUTHIYANGADI: 28 August 2003, Arun Kumar *AK1(L);* 9 April 2004, Arun Kumar *AK17(L)*; 11 April 2004, Arun Kumar *AK17a (L)*; 27 April 2004, Arun Kumar *AK18 (L)*; 27 April 2004, Arun Kumar *AK18a (L)*; 28 April 2004, Arun Kumar *AK18b (L)*; 4 May 2004, Arun Kumar *AK18c (L)*; 8 May 2004, Arun Kumar *AK18d (L)*; 14 July 2004, Arun Kumar *AK67(K(M)158592)*; 10 April 2005, Arun Kumar *AK209*; PAVANGAD: 3 November 2004, Arun Kumar *AK169*; **Malappuram District**, KONDOTTY: 4 November 2004, Arun Kumar *AK170.*

COMMENTS: This species is clearly related to the *Leucocoprinus badhamii* complex comprising species that redden on bruising or become green in ammonia fumes. A comparison of this species with the related taxa in the 'badhamii' complex is given in Kumar & Manimohan (2004). *Leucocoprinus zeylanicus* seems to be another very closely related species with a known distribution in Africa, Sri Lanka (Guzmán & Guzmán-Dávalos 1992), and India (Vrinda et al. 2003). Reports of *Leucocoprinus zeylanicus* from India are based on collections from Kerala State, with descriptions that lack data on reaction with ammonia. A critical comparison of *L. lacrymans* with representative Kerala *L. zeylanicus* collections (TBGT 2069, TBGT 2091, TBGT 2157, TBGT P5345) and also with *L. zeylanicus* descriptions by Pegler (1977, 1986) based on materials collected

from Africa and Sri Lanka confirms a clear distinction between *L. lacrymans* and *L. zelanicus*. The following major differences distinguish *L. zeylanicus*: 1) glabrous stipe; 2) absence of watery exudates on both pileal and stipe surface; 3) smaller spores with a small germ-pore; 4) vesiculose, ovate, clavate, or lanceolate elements of pileal covering, frequently with apical prolongations; and 5) ventricose-fusoid to lageniform elements of stipe covering with a long slender neck.

Leucocoprinus fragilissimus (Berk. & M.A. Curtis) Pat., Essai taxon.: 171 (1900)

Collections examined—**INDIA, Kerala State, Calicut District,** Peruvannamuzhi: 25 May 2004, Arun Kumar *AK35*; 27 May 2004, Arun Kumar *AK35a*; **Wayanad District**, Muthanga: 2 June 2005, Arun Kumar *AK224* (*K(M)158608*) ; 2 June 2005, Arun Kumar *AK240* (*K(M)158607*).

Comments: This remarkable species is readily recognized in the field because of its extremely fragile and short-lived basidiomata. Microscopically *L. fragilissimus* can be easily distinguished by ovoid to broadly ellipsoid spores that are often constricted apically into a short cylindric region terminated by a wide germ-pore plugged with a hyaline exudate-cap.

Leucocoprinus ianthinus (Cooke) Locq., Bull. mens. Soc. linn. Lyon 14: 94 (1945)

Collections examined—**INDIA, Kerala State, Kannur District,** Neeliyarkottam: 16 October 2004, Arun Kumar *AK140*; **Malappuram District,** Calicut University Campus: 20 October 2004, Arun Kumar *AK142 (K(M)158606)*; 10 November 2004, Arun Kumar *AK142a (K(M)158605)*; 16 November 2004, Arun Kumar *AK142b*.

Comments: *Leucocoprinus ianthinus* is easily recognized in the field by its almost fragile basidiomata with a thin, dull white to greyish pileus covered with scattered greyish brown squamules. Its spores are somewhat large and ellipsoid to amygdaliform, cheilocystidia are inflated clavate to ovoid, and pileal covering consists of cylindrical, ellipsoid or clavate elements intermixed with sphaerocysts.

This species is better known under the name *Leucocoprinus lilacinogranulosus* (Henn.) Locq.; the name *L. ianthinus* is used here following Bon (1996) and Vellinga (2001a).

Leucocoprinus acutoumbonatus T.K.A. Kumar & Manim., **sp. nov.** Figure 8

MycoBank MB512341

Pileus 20–60 mm latus, convexus vel conico-companulatus, albidus, ad discum brunneus, umbonatus, squamulis floccoseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 30–55 × 3–5 mm, albidus. Sporae 8–11 × 6–8 µm, ovoideae vel ellipsoideae, poro germinativo instructae. Basidia 21–33 × 10–13.5 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 11–70 × 8–18 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

Holotype — INDIA, Kerala State, Malappuram District, Calicut University Campus: 21 July 2004, Arun Kumar AK72 (K[M]158595).

Etymology: *acutoumbonatus* (Latin), with an acute umbo

Basidiomata small to somewhat medium-sized. Pileus 20–60 mm diam., convex to campanulate when very young, becoming convex to broadly convex and finally conico-campanulate, mostly with a prominent conical umbo, the acuteness of which become pronounced with age; surface dull white for the most part, yellowish white (2A2), towards margin, cinnamon brown (6D6) at the umbo, fibrillose to rather tomentose, with scattered cottony-floccose squamules concentrated more towards the disc, distinctly sulcate-striate towards margin; margin initially incurved, becoming straight, entire to finely serrate. Lamellae free, whitish, turning yellowish brown (5D5) with age, close to crowded, up to 10 mm wide, with lamellulae in 1–4 tiers; edge finely fimbriate to denticulate, concolorous with the sides. Stipe 30–55 × 3–5 mm (up to 10 mm at the base), central, terete, expanding towards base, solid when very young, becoming fistulose to hollow with age; surface whitish with a reddish grey (7B2) tinge, finally turning greyish brown (6D3) with age, turning 'titian red' (7D6) on bruising, pruinose to rather velutinous; base arising from whitish mycelium. Annulus superior, membranous, fixed, with dark brown (6E7) squamules on the upper side. Context less than 2 mm thick, whitish. Stipe context changing to 'titian red' (7D6) on exposure. Odour not distinctive. Spore-print white.

Spores 8–11 × 6–8 (10 ± 1.4 × 7 ± 0.65) µm, Q = 1–1.8, Qm = 1.4, ovoid to ellipsoid with a truncated base and a germ-pore up to 1 mm wide plugged by a lens-cap-like exudate, hyaline, with refractive guttules, thick-walled, smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilic in cotton blue. Basidia 21–33 × 10–13.5 µm, clavate, with guttulate contents, bearing 4 sterigmata up to 5 µm long or occasionally 1–2 abnormally elongated sterigmata up to 16 µm long and 3 µm wide. Lamella-edge sterile. Cheilocystidia 11–70 × 8–18 µm, lageniform or utriform, with subcapitate or long and flexuose or moniliform apex, hyaline to pale grey, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–6 µm wide, inflated up to 10 µm, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses abundant. Pileal trama interwoven; hyphae 2–20 µm wide, inflated, hyaline, thin- to slightly thick-walled, inamyloid. Pileal covering a loose disrupted cutis forming trichodermial patches of ascending or erect chains of somewhat inflated, cylindric to subglobose elements, 15–70 × 5–20 µm, hyaline and slightly thick-walled. Stipe covering a trichodermium of erect cylindrical, lageniform, flexuose elements, 20–70 × 3–8 µm, slightly thick-walled, hyaline or pale grey, with obtuse or acuminate apices. All hyphae lack clamp connections.

Habitat: On the bark of living trees or on decaying wood, solitary or in caespitose groups.

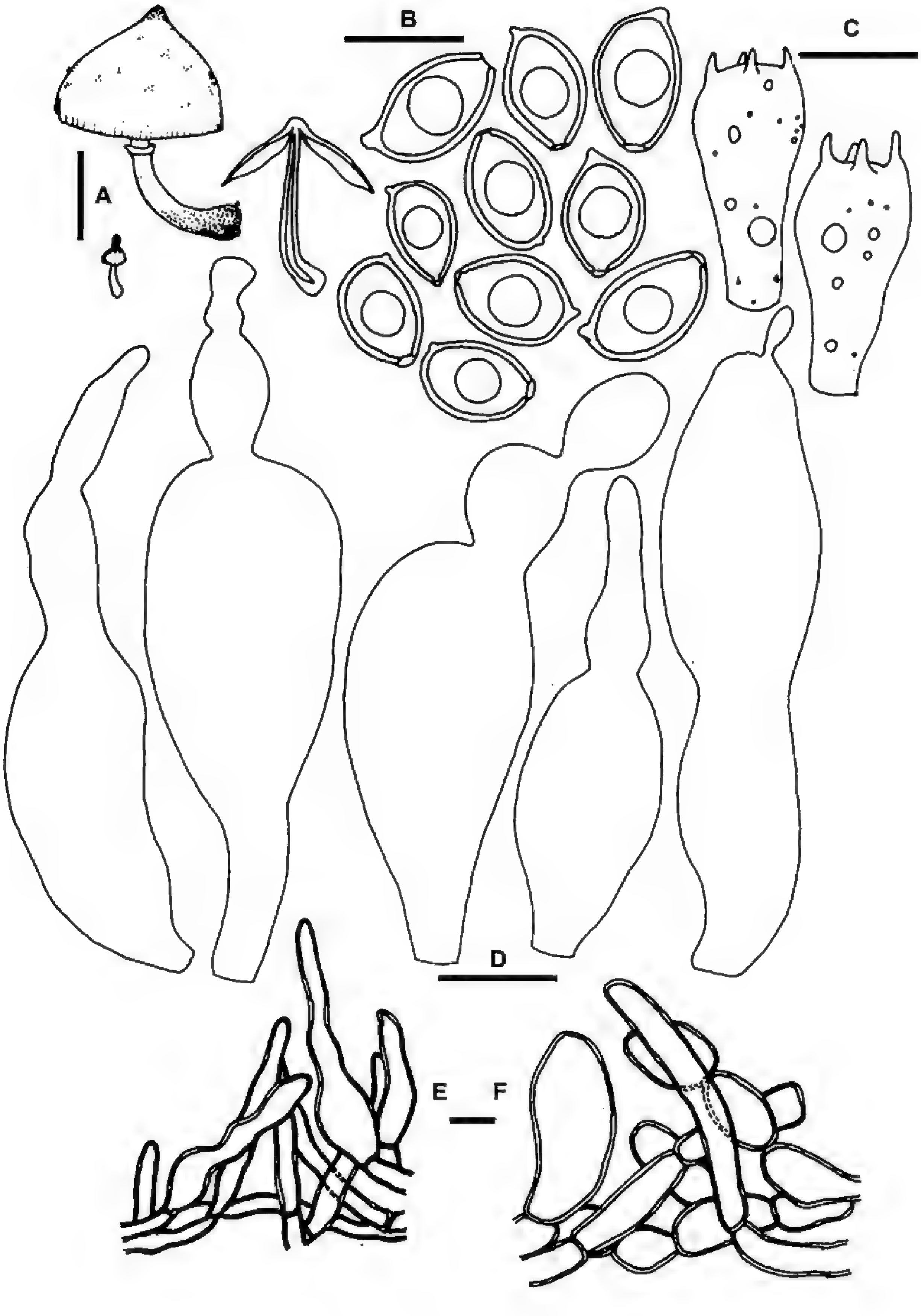

FIGURE 8. *Leucocoprinus acutoumbonatus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

Additional collections examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 10 August 2004, Arun Kumar AK72a; 9 August 2004, Arun Kumar AK87 (*K(M)158594*); 10 August 2004, Arun Kumar AK87a; 12 August 2004, Arun Kumar AK87b; 16 August 2004, Arun Kumar AK87c; 20 August 2004, Arun Kumar AK87d; 22 August 2004, Arun Kumar AK72b; 17 July 2006, Arun Kumar AK417.

Comments: *Leucocoprinus acutoumbonatus* is a very distinct species with an acute umbo, whitish pileus with sulcate striations towards the margin, whitish stipe context turning reddish on bruising, membranous annulus with dark brown squamules on the upper side, large ovoid to ellipsoid spores with a conspicuous germ-pore, lageniform or utriform cheilocystidia with moniliform apex, pileal covering entirely made of loosely attached subglobose to cylindric elements and a trichodermial stipitipellis with erect cylindrical, lageniform or flexuose elements. The presence of distinct striations on the pileus and abundant pseudoparaphyses in the hymenium confirms its position within *Leucocoprinus.*

Although *L. acutoumbonatus* exhibits characters that suggest a close relationship with members of the 'badhamii' complex, including a reddish colour change of the stipe context on bruising, species of the complex show a positive ammonia reaction by turning greenish or (exceptionally) pink (as with *L. croceovelutinus* Bon & Boiffard). *Leucocoprinus acutoumbonatus* is unique in its consistently negative ammonia response, even in repeated tests of basidiomata representing different developmental states. While Reid (1990) includes *L. jubilaei* in his key to the 'badhamii complex' species, he noted that the chemical response of *L. jubilaei* was variable; Babos (1979) earlier had noted a positive ammonia reaction for the species. *Leucocoprinus jubilaei*, a small species also encountered in Kerala, was easily distinguished from the *L. acutoumbonatus* collections by highly deviant macroscopic and microscopic characters. The peculiar nature and composition of the pileal covering, along with several other characters distinguishes *L. acutoumbonatus* from other related species.

Leucocoprinus brebissonii (Godey) Locq., Bull. mens. Soc. Linn. Lyon 12: 41 (1943)

Collections examined — **INDIA, Kerala State, Malappuram District**, Calicut University Campus: 7 October 2004, Arun Kumar *AK126*; 5 November 2004, Arun Kumar *AK171* (*K(M)158603*); 10 November 2004, Arun Kumar *AK171a*; 10 November 2004, Arun Kumar *AK188* (*K(M)158604*); 3 July 2006, Arun Kumar *AK408*.

Comments: The present collections fit in well with the descriptions of *Leucocoprinus brebissonii* given by Smith (1981), Pegler (1983), Babos (1985), Migliozzi et al. (1989), Vellinga (2001a), and Vrinda et al. (2003). Smith's description seems to be based on larger and more robust basidiomata than those of the present collections. A colour photograph and accompanying

species description by Migliozzi et al. (1989) depict basidiomata with brownish squamules on a pale yellow pileal background whereas Vellinga (2001a) describes squamules that may be dark grey-brown, grey-brown, dark brown to almost blackish on a cream coloured or whitish background. An earlier report on the species from Kerala (Vrinda et al. 2003) records the pileal surface as 'teak brown (6F5), dark brown (7F8) at the disc' and with dark brown squamules on a dull white background. Pileal squamules of the present collections are much lighter and devoid of any grey to blackish squamules. This is a regularly fruiting species in the Malappuram District of Kerala, striking in its sharply contrasting squamules against a whitish background.

Leucocoprinus venezuelanus Dennis, Kew Bull. 15: 109 (1961)

Collections examined — **INDIA, Kerala State, Wayanad District**, POOKODE: 26 May 2004, Arun Kumar *AK40* (*K(M)158584*); 27 June 2005, Arun Kumar *AK40a*; **Calicut District**, THAMARASSERY: 26 November 2006, Arun Kumar *AK461* (*K(M)158602*).

Comments: Except for the clavate to inflated-clavate or utriform cheilocystidia, characters of the present collections agree well with the original description of the species from Venezuela (Dennis 1961). The collections also agree with the descriptions provided for materials from the Lesser Antilles (Pegler 1983) and India (Vrinda et al. 2003). *Leucocoprinus venezuelanus* closely resembles *L. brebissonii* with similar basidiomata but differs in having smaller spores. This species is rarely encountered in Kerala, where it has already been reported (Vrinda et al. 2003).

Leucocoprinus delicatulus T.K.A. Kumar & Manim., **sp. nov.** Figure 9

MycoBank MB512342

Pileus 10–41 mm latus, primo convexus, postea applanato expansus, umbonatus, albidus, squamulis griseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 45–60 × 1–2 mm, albidus, vulnerato griseo brunneus. Sporae 9–12 × 6–7 µm, ovo-ellipsoideae vel sub-amygdaliformiae, poro germinativo instructae. Basidia 16–24 × 10–11 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 26–66 × 11–21 µm, clavata,versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

Holotype — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 11 April 2005, Arun Kumar *AK211* (K[M]158582).

Etymology: *delicatulus* (Latin), delicate

Basidiomata small and somewhat fragile. Pileus 10–41 mm diam., convex, becoming broadly convex to applanate, umbonate at the disc; surface whitish with grey (1F1), appressed squamules which are concentrated more towards the disc and sparser towards the margin, pruinose at the disc, distinctly striate towards margin; margin initially incurved, later straight, entire to eroded.

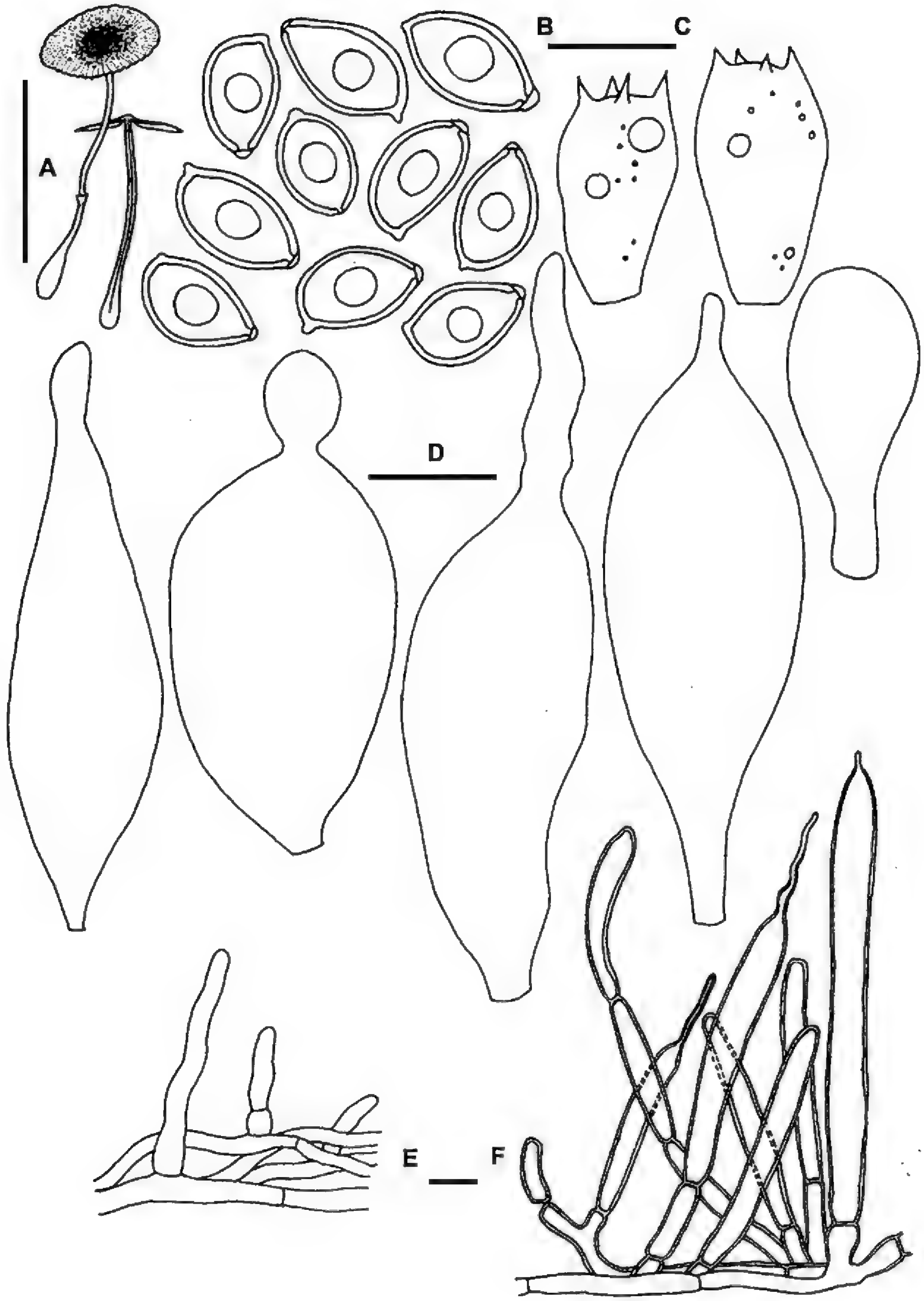

Figure 9. *Leucocoprinus delicatulus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

Lamellae free, whitish, crowded, up to 2 mm wide, with lamellulae in 1–2 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 45–60 × 1–2 mm, (up to 5 mm at the base), central, terete, almost equal with a dilated base, fistulose, becoming hollow; surface whitish, changing to greyish brown (8E3, 9E3) with age or on bruising, fibrillose-villose to rather tomentose; base arising from white mycelium. Annulus inferior, central or superior, membranous, ascending, fixed. Context up to 1 mm thick, whitish. Odour not distinctive. Spore-print white.

Spores 9–12 × 6–7 (10.7 ± 1.09 × 6.8 ± 0.54) µm, Q = 1.4–2, Qm = 1.6, ovo-ellipsoid to subamygdaliform, with a truncate germ-pore covered with a hyaline cap, hyaline, with refractive guttules, thick-walled (up to 2 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilic in cresyl blue. Basidia 16–24 × 10–11 µm, short clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 4 µm long. Lamella-edge sterile. Cheilocystidia crowded, 26–66 × 11–21 µm, clavate, broadly clavate, lageniform, fusiform or utriform, mostly subcapitate or with flexuose apical prolongations (up to 20 µm long), hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 2–6 µm wide, inflated up to 15 µm, branched, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses abundant and well developed. Pileal trama interwoven; composed of 5–20 µm wide, hyaline, thin-walled, inflated hyphae, inamyloid. Pileal covering a cutis disrupted by patches of ascending or erect loosely attached terminal elements and entirely trichodermial at the disc; hyphae 3–10 µm wide, thin-walled, hyaline or with grey to dark grey plasmatic and encrusting pigments; terminal elements 28–100 × 4–10 µm, cylindrical with acuminate to obtuse tips or with short or long flexuose apical extensions, thin- to slightly thick-walled. Stipe covering a cutis disrupted by ascending or erect slightly inflated, cylindric to flexuose terminal elements or side branches of repent hyphae; terminal elements, 24–92 × 7–10 µm; hyphae 3–17 µm wide, thin-walled, hyaline or with grey to dark grey plasmatic pigment. All hyphae devoid of clamp connections.

Habitat: On soil, among decaying leaf litter, solitary or scattered.

Additional collections examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 12 April 2005, Arun Kumar *AK211a*; 13 April 2005, Arun Kumar *AK213* (*K(M)158583*); 3 June 2005, Arun Kumar *AK231*.

Comments: This fragile coprinoid species is diagnosed by large truncate spores, short basidia, versiform cheilocystidia with apical excrescences, and cylindrical pileal elements mostly with abruptly constricted apices. *Leucocoprinus delicatulus* is greatly resembles *Leucocoprinus ianthinus* (= *L. lilacinogranulosus*) in general appearance. However, microscopically the present collection is distinguished from *L. ianthinus* by the cheilocystidia with apical prolongations

and a trichodermial pileal disc entirely made up of cylindric pileal elements that reach up to 100 µm in length.

Leucocoprinus pusillus T.K.A. Kumar & Manim., **sp. nov.** FIGURE 10

MYCOBANK MB512343

Pileus 13–16 mm latus, primo subglobosus, postea convexus, umbonatus, albidus, squamulis brunneis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 20–22 × 3–5 mm, albidus, vulnerato brunneus. Sporae 7–10 × 5–6 µm, ovoideae, ovo-ellipsoideae vel ellipsoideae, poro germinativo instructae. Basidia 18–27 × 9–12 µm, clavata, 4-sporigera. Cheilocystidia 26–49 × 7–21 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

HOLOTYPE — INDIA, KERALA STATE, Thiruvananthapuram District, PALODE: 20 July 2005, Arun Kumar AK367 (K[M]158581).

ETYMOLOGY: *pusillus* (Latin), dwarf

BASIDIOMATA small. PILEUS 13–16 mm diam., subglobose to convex, becoming broadly convex, with a rather indistinct umbo; surface white with scattered, minute, dark brown (8F8) to dark grey (8F1), fibrillose squamules that are more concentrated and recurved at the disc, distinctly sulcate-striate towards margin; margin initially incurved, later straight, entire. LAMELLAE free, whitish, turning yellowish white (3A2) to brown (6E6) with age and on drying, crowded, up to 2 mm wide, with lamellulae in 3–4 tiers; edge finely fimbriate under a lens, concolorous with the sides. STIPE 20–22 × 3–5 mm, central, terete, expanding towards base, fistulose; surface whitish, turning brown (6E5, 6E6) on bruising, fibrillose; base arising from a whitish mycelium. ANNULUS superior, membranous, ascending, with a rim covered with dark brown (8F8) fibrillose scales. CONTEXT up to 1 mm thick, whitish, turning brown (6E6) on exposure. ODOUR not distinctive. SPORE-PRINT not obtained.

SPORES 7–10 (11) × 5–6 (7) (8 ± 1 × 5.9 ± 0.54) µm, Q = 1.2–1.6, Qm = 1.4, ovoid, ovo-ellipsoid, or ellipsoid, with a rather inconspicuous germ-pore (up to 1 µm in some), hyaline, with refractive guttules, thick-walled (up to 1.5 µm), smooth, dextrinoid, metachromatic in cresyl blue, cyanophilic in cotton blue. BASIDIA 18–27 × 9–12 µm, clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 µm long. CHEILOCYSTIDIA crowded, 26–49 × 7–19 µm, cylindrico-clavate, clavate, inflated clavate, or utriform, many with a slightly mucronate apex (up to 3 µm long), hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 2–5 µm wide, inflated up to 16 µm, hyaline, thin-walled, inamyloid. SUBHYMENIUM cellular. PSEUDOPARAPHYSES well developed. PILEAL TRAMA interwoven; hyphae 3–17 µm wide, hyaline, thin- to slightly thick-walled, slightly inflated, inamyloid. PILEAL COVERING a cutis composed of filamentous, 2–15 µm wide, slightly agglutinated, hyaline to pale greyish, thick-walled (up to 1 µm) hyphae, which becomes highly

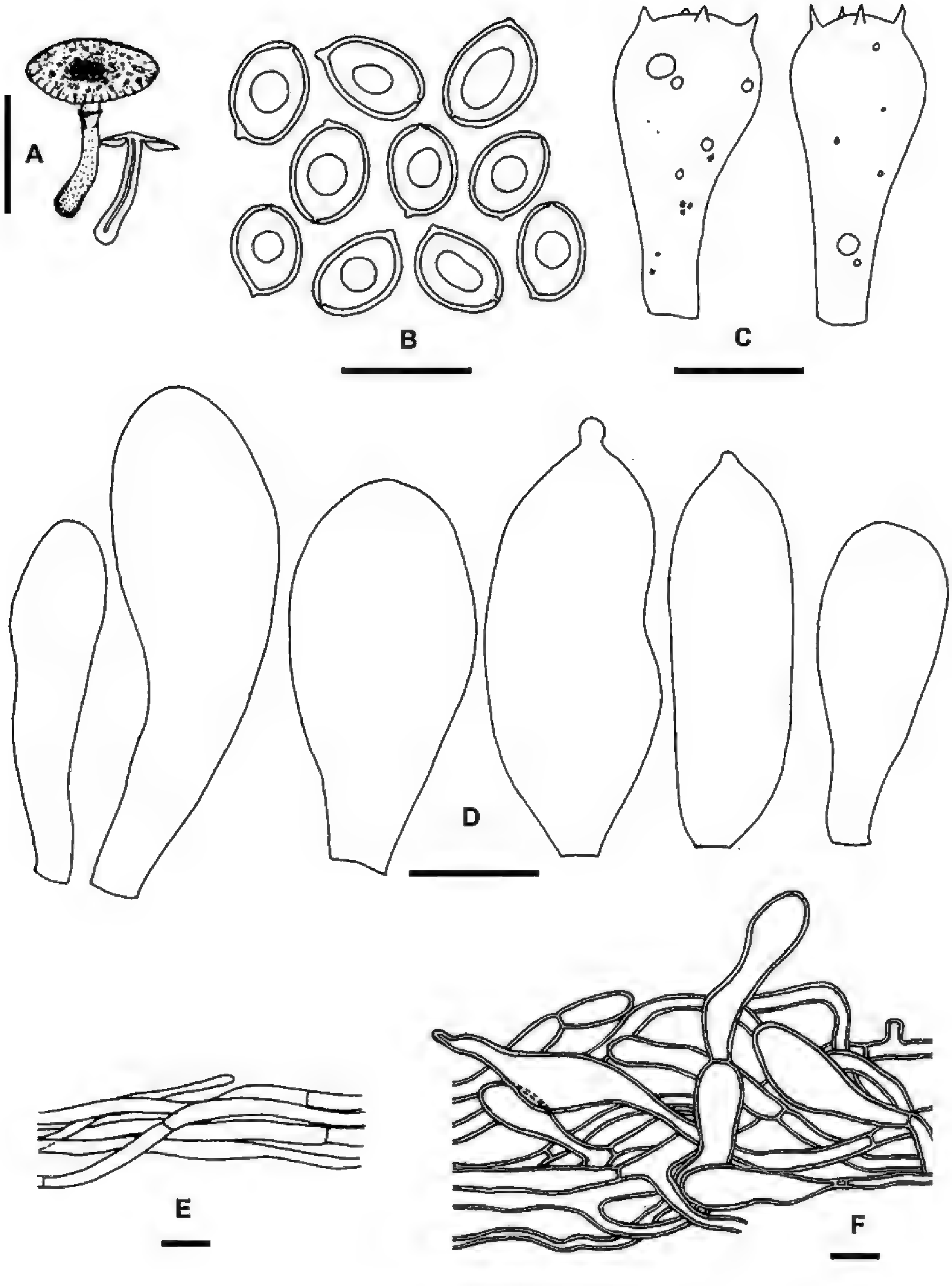

FIGURE 10. *Leucocoprinus pusillus*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

disrupted and irregular at the disc and at the scales, with ascending or erect terminal elements; terminal elements 17–69 × 5–17 µm, mostly clavate or lageniform, rarely cylindrico-clavate, or utriform, thick-walled (up to 1 µm), with dark greyish brown plasmatic, membrane-, and encrusting pigments. STIPE COVERING a cutis of 2–12 µm wide, thin-walled, hyaline or pale yellow to brownish, slightly agglutinated hyphae with cylindrical end-cells. Clamp connections absent.

HABITAT: On organic manure rich soil, solitary.

ADDITIONAL COLLECTIONS EXAMINED — **INDIA, KERALA STATE, Thiruvananthapuram District,** PALODE: 20 July 2005, Arun Kumar *TBGT 9140*.

COMMENTS: *Leucocoprinus pusillus* is a striking species with ellipsoid to ovo-ellipsoid spores with an inconspicuous germ-pore, cheilocystidia rarely with a mucronate apex, and thick-walled pileal elements with plasmatic, membrane-, and encrusting pigments. This character combination indicates affiliation with the '*Leucocoprinus badhamii* complex' characterized by Reid (1990) for species with a rubescent flesh that becomes green in ammonia fumes. A colour reaction on exposure to ammonia was found to be absent in the present species, although the context turned brown (6E5, 6E6) on bruising. Within the 'badhamii complex,' *Leucocoprinus croceovelutinus* does not turn green on exposure to ammonia. Although Babos (1979) reports this as a negative reaction, *L. croceovelutinus* exceptionally reacts positively by turning pink on exposure to ammonia fumes. That species, however, is of moderate size (pileus 30–40 mm diam.) with a non-striate pileal margin. It reddens on bruising and has spores with a distinct papillate apex without a germ-pore and cheilocystidia with prominent apical prolongation. The negative reaction with ammonia and the characteristically small size of basidiomata of the present collections keeps it distinct from all other members of the group. *Leucocoprinus jubilaei*, also with a negative colour reaction with ammonia, differs primarily by the basidiome size and spore characteristics.

Leucocoprinus munnarensis T.K.A. Kumar & Manim., **sp. nov.** FIGURE 11

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Pileus 27–51 mm latus, primo convexus, postea applanato expansus, umbonatus, albidus, squamulis granulareis griseis ad discum confertioribus obtectus, ad marginem striatus. Lamellae liberae, albidae, confertae. Stipes 50–80 × 3–5 mm, albidus, vulnerato brunneus. Sporae 8.5–12.5 × 6–8 µm, amygdaliformiae, poro germinativo instructae. Basidia 19–22 × 10–11 µm, clavata, 4-sporigera. Cheilocystidia 20–39 × 7–21 µm, versiformia. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes defibulatae.

HOLOTYPE — **INDIA, KERALA STATE, Idukki District,** MADUPETTY: 10 June 2006, Arun Kumar AK393 (K[M]158580).

ETYMOLOGY: *munnarensis* (Latin), pertaining to the type locality, Munnar.

Basidiomata small to somewhat medium-sized. Pileus 27–51 mm diam., initially convex, becoming broadly convex to applanate, umbonate at the disc; surface whitish with scattered, minute, dark grey (1F1) to blackish, squamules that are almost granular and more concentrated towards the centre and sparser towards the margin, distinctly striate towards margin; margin initially incurved, later straight, entire or slightly eroded in some specimen. Lamellae free, whitish, crowded, up to 2.5 mm wide, with lamellulae in 2–5 tiers; edge fimbriate under a lens, concolorous with the sides. Stipe 50–80 × 3–5 mm, (up to 5 mm at the base), central, terete, almost equal, slightly expanding towards base, fistulose, finally becoming hollow; surface whitish, turning brown (6E5, 6E6) on touch, on bruising or when cut, fibrillose; base arising from whitish mycelium. Annulus superior, membranous, movable, evanescent. Context up to 1 mm thick, whitish, gradually turning brown (6E5) on exposure. Odour not distinctive. Spore-print not obtained.

Spores 8.5–12.5 × 6–8 (10.4 ± 1.04 × 7 ± 0.54) µm, Q = 1.3–1.7, Qm = 1.5, amygdaliform, with a germ-pore covered by a hyaline pore-cap, hyaline, with refractive guttules, thick-walled (up to 1 µm), smooth, dextrinoid, distinctly metachromatic in cresyl blue, cyanophilous in cotton blue. Basidia 19–22 × 10–11 µm, clavate, hyaline, with guttulate contents, bearing 2–4 sterigmata up to 7 µm long. Cheilocystidia crowded, 41–66 × 10–25 µm, clavate, versiform: inflated clavate, narrowly lageniform, or utriform, mostly with cylindrical or flexuose apical prolongations up to 27 µm long, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 3–15 µm wide, inflated up to 30 µm, hyaline, thin-walled, inamyloid. Subhymenium cellular. Pseudoparaphyses well developed and prominent. Pileal trama interwoven; composed of 5–25 µm wide, hyaline, thin-walled, inflated, inamyloid hyphae. Pileal covering a disrupted cutis composed of 3–25 µm wide, slightly inflated, thin- to slightly thick-walled, grey to dark grey pigmented hyphae, with ascending or erect trichodermial patches of fusoid or cylindrical, thin- to slightly thick-walled terminal elements, 43–190 × 4–10 µm, with obtuse tips. Stipe covering a cutis of 4–11 µm wide, thin-walled, hyaline hyphae, disrupted by bundles of ascending or erect terminal elements; terminal elements; 30–57 × 3–7 µm, cylindrical, with hyaline to pale grey plasmatic pigment. All hyphae lack clamp connections.

Habitat: On soil, solitary or scattered.

Comments: The distinctive characters of *Leucocoprinus munnarensis* are basidiomata that bruise brown but do not change colour with ammonia, large spores with a broad germ-pore covered by a hyaline cap, cheilocystidia with mucronate apex, and a trichodermial pileal disc made up entirely of fusoid or cylindric terminal elements that may reach up to 190 µm in length. *Leucocoprinus brebissonii*, earlier reported from Kerala (Vrinda et al. 2003),

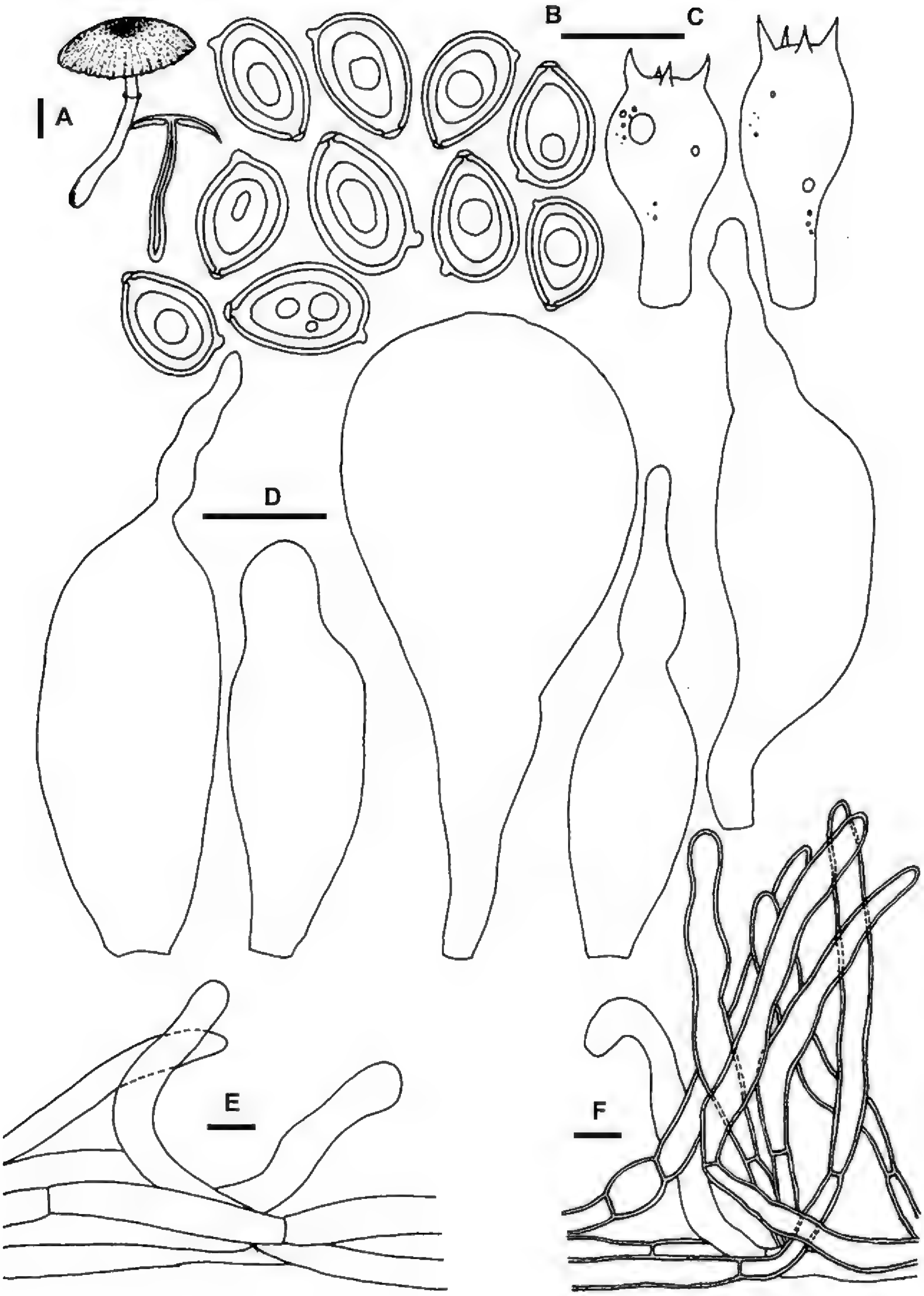

FIGURE 11. *Leucocoprinus munnarensis*:
A, habit, scale bar = 10 mm; B, basidiospores; C, basidia;
D, cheilocystidia; E, stipe covering; F, pileus covering.
Scale bars (B–F) = 10 µm.

seems very close, but *L. munnarensis* does not agree with descriptions of *L. brebissonii* (Candusso & Lanzoni 1990, Bon 1996, Vellinga 2001a, Vrinda et al. 2003) due to its basidiomata bruising brownish and the absence of the terminal pileal covering cells that are 'cylindrical and short to ellipsoid-clavate to globose elements, in chains or disorderly arrangements' that characterize *L. brebissonii* (Vellinga 2001a). Vrinda et al. (2003) described the covering at the pileal disc of *L. brebissonii* as 'hymeniform' with 'clavate to ovoid, detersile elements.' A comparison with the colour photograph of *L. brebissonii* in Migliozzi et al. (1989: 27) also supports separation of the two species.

Leucocoprinus cretaceus (Bull.) Locq., Bull. mens. Soc. Linn. Lyon 14: 93 (1945)

Collections examined — **INDIA, Kerala State, Malappuram District,** Calicut University Campus: 8 October 2003, Arun Kumar *AK3*; 4 May 2004, Arun Kumar *AK19*; 5 May 2004, Arun Kumar *AK21* (*K(M)158576*); 6 May 2004, Arun Kumar *AK21a*; 29 June 2004, Arun Kumar *AK60*; 19 July 2004, Arun Kumar *AK69*; 8 July 2006, Arun Kumar *AK437* (*K(M)158575*).

Comments: Characters of the Kerala collections agree with those of the species from Sri Lanka as given by Pegler (1986) under the name *Leucocoprinus cepistipes*. However, *L. cepistipes* seems to have been misapplied to the taxon currently recognized as *L. cretaceus* (see Vellinga 2001a). *Leucocoprinus cretaceus* is characterized by somewhat large basidiomata with chalk-white, cottony or plush-like, detersile squamules on the pileus and stipe, spores often with a conspicuous hyaline cap over the germ-pore, and cylindrical or slightly branched pileal covering elements. Remarkably, our collections from Kerala agree well with Vellinga's (2001a) description of *L. cretaceus*, and therefore our collections are treated here under that epithet. *Leucocoprinus cepistipes* in the present sense has a pileus with brownish centre and uplifted brownish squamules, stipe with a densely and finely pubescent surface, spores with germ-pore lacking a distinct hyaline cap, and cylindrical to narrowly lageniform terminal elements on the pileus and stipe covering.

Leucocoprinus birnbaumii (Corda) Singer, Sydowia 15: 67 (1962) ["1961"]

Collections examined — **INDIA, Kerala State, Calicut District,** Puthiyangadi: 25 July 2004, Arun Kumar *AK82* (*K(M)158574*); 1 September 2004, Arun Kumar *AK82a*; **Wayanad District**, KALPETTA: 26 May 2004, Arun Kumar *AK39*; **Malappuram District**, Calicut University Campus: 2 June 2004, Arun Kumar *AK42*.

Comments: This species, easily identified by its yellowish basidiomata, ovoid to ellipsoid spores with a germ-pore, and cylindrical pileal surface elements, is one of the most widely known and studied lepiotaceous fungi. Although cosmopolitan in distribution, *L. birnbaumii* is encountered in the temperate regions in green houses and botanic gardens maintaining tropical plants. This species has already been reported from Kerala by Vrinda et al. (2003).

Leucocoprinus jubilaei (Joss.) Wasser, Novit. Syst. Plant. non Vasc. 2: 191 (1976)

Collections examined — **INDIA, Kerala State, Malappuram District**, Calicut University Campus: 15 October 2004, Arun Kumar *AK137* (*K(M)158572*); 26 October 2004, Arun Kumar *AK148*; 26 October 2004 Arun Kumar *AK149*; 1 November 2004, Arun Kumar *AK148a*; 2 November 2004, Arun Kumar *AK163* (*K(M)158573*); 5 November 2004, Arun Kumar *AK172*; 9 November 2004, Arun Kumar *AK172a*; 10 November 2004, Arun Kumar *AK172b*; 16 November 2004, Arun Kumar *AK202*; **Thiruvananthapuram District**, PALODE: 18 July 2005, Arun Kumar *AK368*; 20 July 2005, Arun Kumar *AK371*; 3 August 2006, Arun Kumar *AK424*; 4 August 2006, Arun Kumar *AK427*.

Comments: As already noted, *L. jubilaei* belongs to the 'badhamii complex'. The present collections differ from the species as described by Babos (1979) in showing a negative ammonia reactivity and absence of coloured pigments in cheilocystidia. It differs from the account given by Reid (1990) in smaller basidiome size and cheilocystidial morphology. In his comprehensive discussion on the species, Reid (1990) notes, "Ammonia gives a variable reaction from intense green to a rather feeble grey-green to absolutely no reaction," which supports the negative chemical response of the Kerala collections. Hungarian specimens studied by Babos (1979) often possessed cheilocystidia with versiform appendages that were up to 54 µm long although she did note the lack of apical appendages in Josserand's material and original descriptions, suggesting that basidiome developmental stage might explain the presence/absence of such outgrowths. Except for these deviating characters, the present collections are in close agreement with *L. jubilaei*. This is a rather common *Leucocoprinus* species found throughout Kerala.

Leucocoprinus submontagnei Heinem., Bull. Jard. Bot. Nation. Belg. 47: 84 (1977)

Collections examined — **INDIA, Kerala State, Calicut District**, Puthiyangadi: 29 October 2003, Arun Kumar *AK9*; 12 November 2003, Arun Kumar *AK9a*; 9 May 2004, Arun Kumar *AK23* (*K(M)158600*); 19 May 2004, Arun Kumar *AK23a*; 21 May 2004, Arun Kumar *AK23b*; **Malappuram District**, Calicut University Campus: 24 May 2004, Arun Kumar *AK31*; 24 May 2004, Arun Kumar *AK32*; 3 June 2004, Arun Kumar *AK43*; 9 November 2004, Arun Kumar *AK179* (*K(M)158599*); 10 November 2004, Arun Kumar *AK179a*; 10 November 2004, Arun Kumar *AK189*; 28 June 2005, Arun Kumar *AK320*.

Comments: *Leucocoprinus submontagnei* is a widespread species in Kerala. It is a fragile species characterized by a whitish to yellowish white pileus that is distinctly sulcate-striate towards the margin; ovoid, ellipsoid or broadly ellipsoid spores with an indistinct germ-pore; and a pileal covering with cylindric elements projecting from chains of more or less ovoid to ellipsoid cells. Except for their slightly larger spores, the present collections agree with the diagnostic characters of the African species (Heinemann 1977, Pegler 1977). *Leucocoprinus lanzonii* Bon et al. closely resembles *L. submontagnei* in general appearance and

in most microscopic features but differs in having slightly larger basidiomata and smaller spores. Other related species like *L. medioflavus* (Boud.) Bon and *L. denudatus* (Rabenh.) Singer could also be distinguished based chiefly on basidiome size and smaller spores. Although it has subglobose spores lacking a germ-pore, *Leucocoprinus denudatus* differs in the arrangement and shapes of its pileal elements. *Leucocoprinus truncatus* (A. Pearson) D.A. Reid & Eicker (Reid & Eicker 1993), which resembles *L. submontagnei* in general appearance and has an almost identical cuticular structure, can be separated by its thick annulus with brownish rim and larger amygdaliform spores with apical germ-pore.

Leucocoprinus straminellus (Bagl.) Narducci & Caroti, Memorie Soc. Tosc. Sci. Nat., Ser. B 102: 49 (1996) ["1995"]

Collection examined — **INDIA, Kerala State, Calicut District,** PERUVANNAMUZHI: 25 May 2004, Arun Kumar *AK34* (*K(M)158571).*

Comments: This species has granular squamules scattered on a whitish to yellowish white pileal background, distinct striations towards the margin, and a pileal covering with epithelial patches of sphaerocysts. Characters of the present collection agree with the description of *L. straminellus* by Vellinga (2001a) except for the dark brown coloured squamules, smaller spores (5–6.5 × 3.5–4.5 µm), and absence of lageniform cheilocystidia. No annulus was seen in the Kerala collection.

The well-known *L. denudatus* is now considered a synonym of *L. straminellus* (Vellinga 2001a). Comparison with the Migliozzi et al. (1989) colour photograph of *L. denudatus* indicates an overall macroscopic similarity except for the more yellowish pileus with concolorous squamules. Despite the colour variation, the microscopical similarities are evident from the accompanying description.

Leucocoprinus cygneus (J.E. Lange) Bon is a related species with white lamellae, amygdaliform spores, larger cheilocystidia that are mostly lageniform and reaching up to 100 µm long, and pileal elements with encrusting pigments. *Leucocoprinus submontagnei* Heinem. has white lamellae and much larger spores ((5.4–)6.5–8.1(–9.0) × 4.2–5.1, from the original account by Heinemann 1977). *Lepiota micropholis* (Berk. & Broome) Sacc. with a plicate-striate pileus differs chiefly in having larger basidiomata, persistent annulus, and in missing sphaerocysts in the pileal covering.

Taxonomic observations

As already noted, Singer (1986) considered the presence of pseudoparaphyses as an important marker to recognize *Leucocoprinus* species although a preliminary molecular study (Vellinga 2004b) does not support this view. Our recent observations of numerous fresh and dried representatives of *Leucocoprinus*

species suggest that the presence of pseudoparaphyses is indeed a strong diagnostic character for a morphological-based concept of *Leucocoprinus*. Determining hymenial pseudoparaphyses based solely on shape was often difficult; we stained a lamellar cross-section with a mixture of 1% aqueous phloxine and Congo red solutions for 10 minutes and then washed with 3% aqueous KOH to remove excess stain, which exposed notable difference between the degree of stain retained by the pseudoparaphyses and other hymenial cells. Basidia stained bright pinkish orange to red, indicating a high affinity for both Congo red and phloxine, while the pseudoparaphyses stained much lighter. The cell walls of the pseudoparaphyses stained with the wall-specific Congo red; the lack of phloxine stain indicated an absence or shortage of cytoplasm. We found it easy to distinguish between *Leucoagaricus* and *Leucocoprinus* by using this differential staining technique to check for pseudoparaphyses.

Another interesting observation is that clamp connections appear completely absent only in *Leucocoprinus* species and are observed, although rarely, in many *Leucoagaricus* species collected from Kerala. Clamp connections have been observed in some other *Leucoagaricus* species (see discussion under *L. majusculus*) as well (Wasser 1993). This contradicts the original taxonomic concepts where both genera were regarded as generally clampless. Based on our observations, we feel that 'absence of clamp connections' as a distinguishing character should be restricted to *Leucocoprinus* species. The absence of clamp connections in species belonging to the "badhamii complex" substantiates our consideration of those species under *Leucocoprinus*.

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MYCOTAXON

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Marasmioid and gymnopoid fungi of the Republic of Korea. 1. Three interesting species of *Crinipellis* (*Basidiomycota, Marasmiaceae*)

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Abstract — Two new *Crinipellis* taxa (*Basidiomycota, Marasmiaceae*) collected in the Republic of Korea, *C. rhizomaticola* and *C. nigricaulis* var. *macrospora*, are described. A third species, *Crinipellis zonata*, is recorded for the first time in this country. Their macro- and microscopic descriptions and molecular characteristics are also given. ITS regions of rDNA were studied in all collections. The combination, *C. trichialis,* is validated.

Key words — euagarics, taxonomy, phylogeny

Introduction

During field excursions to various localities in the Republic of Korea (South Korea) in 2007 and 2008, the authors collected rich material of marasmioid and gymnopoid fungi. During these excursions three interesting *Crinipellis* species were found. After comparison with the literature, two are described here as a new species and a new variety, respectively, and the third, *Crinipellis zonata*, was recorded for the first time in the Republic of Korea. Previously only two species of *Crinipellis* — *C. cremoricolor* R.L. Schaffer & M.G. Weaver and *C. scabella* (Alb. & Schwein.) Murrill (as *C. stipitaria* (Fr.) Pat.) — had been recorded in the Republic of Korea (Kim 1991, Lee & Lee 1991, Park & Lee 1991). Besides a detailed morphological analysis, a phylogenetic analysis of ITS rDNA sequences was also conducted to investigate their relationship.

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Materials and methods

Macroscopic descriptions are based on fresh basidiocarps. Microscopic features are described from dried material mounted in KOH, Melzer's reagent, and Congo Red using an Olympus BX-50 light microscope with a magnification of 1000×. For basidiospores, the factors E (quotient of length and width in any one spore) and Q (mean of E-values) are used. For lamellae, L means the number of entire lamellae and l the number of lamellulae between each pair of entire lamellae. Authors of fungal names are cited according to the International Plant Names Index Authors website (http://www.ipni.org/ipni/authorsearchpage.do), and colour abbreviations follow Kornerup & Wanscher (1983). Herbarium specimens are preserved in the herbarium of the Moravian Museum, Dept. of Botany, Brno, Czech Republic (BRNM). The type specimen of *Crinipellis nigricaulis* Har. Takahashi was borrowed from the Natural History Museum and Institute, Chiba, Japan (CBM-FB), which granted permission to extract and sequence ITS rDNA for comparison purposes.

Genomic DNA was extracted from small (3–4 mm^3) tissue samples from five specimens (BRNM 712569, 712570, 712579, 712580, CBM-FB-24125) following procedures set forth by Lee & Taylor (1990). ITS1-F and ITS4-B primers (Gardes & Bruns 1993) were used to amplify the complete rDNA ITS region. Temperature cycling included denaturation (30 s at 94 °C), annealing (30 s at 56 °C), and extension (60 s at 72 °C). Thirty-five cycles were run with the first denaturation and last extension times extended to 2 and 5 min, respectively. Purified PCR products were directly sequenced on an ABI Prism TM 377 DNA automatic DNA Sequencer (Applied Biosystems, Foster City, CA, USA) using a BigDye™ cycle sequencing kit, version 3.1 (Applied Biosystems), and the ITS1-F and ITS4-B primers used for amplification.

Sequences were edited with the DNASTAR software, version 5.0.5 (DNAStar, Madison, WI, USA). Sequences were aligned using CLUSTAL_X (Thompson et al. 1997). Phylogenetic trees were obtained using the Bayesian (MCMC) and maximum parsimony (MP) methods. MCMC analysis was performed using MRBAYES, version 3.0b4 (Ronquist & Huelsenbeck 2003), which generated a Bayesian inference of the phylogeny, using Metropolis coupled Markov chain Monte Carlo analyses (Geyer 1991). The general time reversible (GTR) model was employed with gamma-distributed substitution rates. Markov chains were run for 10^6 generations, saving a tree every 100^{th} generation, with the first 1000 trees discarded as burn-in. MRBAYES was used to compute a 50 % majority rule consensus of the remaining trees to obtain estimates for group posterior probabilities (PPs). Branch lengths were computed as the mean values over the trees sampled. Result reproducibility was tested by repeating this analysis five times using with random trees and program default parameter values. MP analysis was performed in PAUP*, version 4b10 (Swofford 2002) using heuristic searches with ten random sequence additions and branch swapping by tree bisection-reconnection (TBR). Relative robustness of the individual branches was estimated by bootstrapping (BS), using 10,000 replicates.

Moniliophthora species sequences were added to our studies based on recent molecular studies (Aime & Phillips-Mora 2005) that imply a monophyletic clade distinct from *Crinipellis* comprising *Crinipellis perniciosa* (Stahel) Singer and anamorphic fungi parasitic on cocoa (*Theobroma cacao*) and now included in the genus *Moniliophthora*

H.C. Evans et al. Two *Chaetocalathus liliputianus* sequences were selected as an outgroup based on a study by Matheny et al. (2006).

Taxonomy

Crinipellis nigricaulis* var. *macrospora Antonín, R. Ryoo & H.D. Shin **var. nov.**

MycoBank MB 513106, NCBI accession numbers FJ573196, FJ573197 Fig. 1

A varietate typica basidiosporis magnis, 10–11.5 × 3.75–4.75(–5.0) µm et cheilo-cystidiis brevis, 13–17(–20) × 4.5–6.0(–7.0) µm, differt.

Holotypus: Republic of Korea, Chuncheon, Dongsan-myeon, Bongmyeong-ri, 22.VII.2007, leg. V. Antonín 07.96 et R. Ryoo (holotypus in herbario BRNM 712569 preservatur).

Basidiocarps single. Pileus 1.5–5 mm broad, convex with a distinct, obtuse to almost applanate umbo with central papilla and abrupt and inflexed margin, later papilla less distinct and margin not inflexed, entirely radially adpressed fibrillose-hairy with ± smooth centre when young, later hairs disappearing from margin, remaining only around centre in older basidiocarps, entirely brown to dark brown (6E4 to 7E5–6) when young, then dark brown only at centre and around it, whitish towards margin; older specimens slightly striate-sulcate up to ¾ with slightly crenulate margin. Lamellae moderately close, L = 16–20, l = (0–)1(–2), emarginate and with small tooth, well-developed, pale cream with concolorous pubescent edge. Stipe very long, 55–200 mm, filiform, insititious, entirely distinctly hairy, concolorous with lamellae at apex, through brown (7E4–5) to dark brown (7F4–5) towards base, entirely brown in old basidiocarps. Rhizomorphs present, slightly hairy, brown-black.

Basidiospores 8.5–11.5 × 3.75–4.75(–5.0) µm, average = 10.1 × 4.1 µm, E = 2.2–3.0, Q = 2.4–2.6, fusoid, thin- or slightly thick-walled, non-dextrinoid. Basidia not observed. Basidioles 10–23 × 2.5–8.0 µm, fusoid, clavate, cylindrical. Cheilocystidia in the form of broom cells of the Siccus-type, 12–20 × 4.0–7.0 µm, clavate, (sub)cylindrical, subfusoid, thin-walled, hyaline; projections up to 8(–10) × 2.0 µm, digitate, thin- to slightly thick-walled, obtuse to subacute. Pleurocystidia absent. Trama hyphae ± cylindrical, thin- to slightly thick-walled, hyaline, up to 10 µm wide. Pilei-pellis a cutis of ± cylindrical, thin- to slightly thick-walled, mostly incrusted, dextrinoid or non-dextrinoid, up to 12 µm wide hyphae. Pileus hairs cylindrical, thick-walled (walls up to 1.5 µm thick), obtuse, less frequently subacute to acute, septate, ± irregular at base, up to c. 650 × 9.0 µm, dextrinoid, with walls pale yellow-brown in H_2O and olivaceous in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0 µm wide hyphae with olivaceous walls in KOH. Stipe hairs similar to pileus hairs, 30–400 × up to 8.0 µm, septate, thick-walled, mostly acute, less frequently obtuse, dextrinoid. Clamp connections present in all tissues.

HABITAT — On leaves of *Quercus mongolica*, *Quercus* sp., *Betula platyphylla* var. *japonica* and *Juglans mandshurica*.

LOCALITIES — Republic of Korea, Chuncheon, Dongsan-myeon, Bongmyeong-ri, Experimental forest of Kangwon National University, 37° 46' 46" N, 127° 48' 59" E, alt. 212 m, 22 July 2007, leg. V. Antonín 07.96 and R. Ryoo (holotype, BRNM 712569). – Republic of Korea, Pyeongchang, Chungtaesan Resort Forest, 37° 31' 24.78" N, 128° 17' 22.58" E, alt. 764 m, 17 July 2008, leg. R. Ryoo KG 231 (BRNM 712580).

ADDITIONALLY REVISED SPECIMENS — *Crinipellis nigricaulis* var. *nigricaulis*: Japan, Kanawaga pref., Zushi-shi, 12 July 1996, leg. et det. H. Takahashi (CBM-FB 24125, paratype). – Japan, Kanawaga pref., Odawara-shi, 27 Sept. 1998, leg. et det. H. Takahashi (CBM-FB 24127, paratype).

REMARKS — *Crinipellis nigricaulis* var. *macrospora* is characterised by a small, entirely brown to dark brown, then marginally whitish pileus, a very long filiform stipe, moderately large basidiospores, and cheilocystidia in the form of broom cells of the Siccus-type. Having olivaceous-coloured hairs in KOH, it belongs to sect. *Grisentinae* (Singer) Singer (Singer 1976, 1986).

The type variety of *C. nigricaulis* (Takahashi 2000) differs by basidiospores with different E and Q factors (8.0–11 × 4.5–6.0 µm, E = 1.6–2.2, Q = 1.8–1.9) and broader cheilocystidia (15–23 × 6–11 µm). Other characters and habit agree with our collection (CBM-FB 24125 and 24127, paratypes!). It is known only from Japan.

Crinipellis actinophora (Berk. & Broome) Singer differs by its habit (see drawings by Pegler 1986), a blackish brown pileus centre and smaller basidiospores (7–9.7 × 3.4–4.7 µm). According to a description by Corner (1996, as *C.* cf. *actinophora*), it has a larger pileus (8–12 mm), a much shorter stipe (8–15 × 0.5 mm) and smaller basidiospores (7.5–9 × 4–4.5 µm); however he does not mention the presence of cheilocystidia and their form. *Crinipellis alcalivirens* Singer has a larger, 6–12 mm broad, rusty to chestnut-brown pileus, a shorter stipe (12–14 × 0.6–0.8 mm), shorter and broader basidiospores (7.5–8.5 × 4.5–5.7 µm), different cheilocystidia not in the form of broom cells and possesses pleurocystidia. *Crinipellis trichialis* (Lév.) Pat. ex Antonín, R. Ryoo & H.D. Shin, **comb. nov.** MYCOBANK MB513425 [Basionym: *Agaricus trichialis* Lév., Ann. Sci. Nat., Bot. 3e Sér., 5: 113. 1846.] has a distinctly shorter stipe (3–9 × 0.3–1 mm), shorter and broader basidiospores (7.3–9.7(–10.2) × 4–6.7 µm), different cheilocystidia not in the form of broom cells, and possesses pleurocystidia; moreover, both of them grow on dead parts of monocotyledons (Singer 1976). Among species occurring on dicotyledons, *C. sapindacearum* Singer especially differs by a distinctly shorter stipe (9–14 × 0.4–0.5 mm), smaller basidiospores (7.5–8.2 × 3–6.5 µm), and present pleurocystidia. *Crinipellis tucumanensis* Singer also differs by a shorter stipe (13–36 × 0.3–1 mm), smaller basidiospores (5.5–8.5 × 4–6 µm), and present pleurocystidia, and has differently shaped cheilocystidia (Singer 1976).

Crinipellis rhizomaticola Antonín, R. Ryoo & H.D. Shin **sp. nov.** FIG. 2

MYCOBANK MB 513107, NCBI accession number FJ573198

Pileo 12–22 mm lato, conico vel convexo-conico, papillato, centro obscuriore brunneo, marginem pallido. Lamellis cremeis. Stipite 40–60 × 0.75–1.25 mm, apicem pallide brunneo, ad basim obscuriore brunneo. Basidiosporis 8.5–10 × 4.0–5.0(–5.25) µm, fusiformibus-ellipsoideis, lacrimoideis, hyalinis, inamyloideis. Cheilo-cystidiis 17–32 × 4.0–7.0 µm, clavatis vel subcylindraceis, cum 1–3(–4) projec-tionibus apicularibus. Pleurocystidiis 34–42 × 7.5–9.5 µm, clavatis, tunicatis. Pilis pilei usque c. 700 × 3.0–7.0 µm, cylindraceis, crassitunicatis, dext-rinoideis, in KOH olivaceis. Hyphis fibulatis. Ad rhizomatibus putridis.

HOLOTYPUS: Republic of Korea, Jeju, insula Udo, 4.VII.2008, leg. V. Antonín 08.55 et R. Ryoo (holotypus in herbario BRNM 712570 preservatur).

BASIDIOCARPS single. PILEUS 12–22 mm broad, conical, then convex-conical, always with a small and sharp papilla at ± subapplanate centre, margin inflexed, then straight, centre always chestnut-brown (8E–F8) and tomentose, otherwise radially adpressed hairy on paler, pale yellow or pale orange (4–5A3) ground, hairs of the same colour as pileus centre; margin slightly (when young) to ± distinctly (when old) sulcate and crenulate. LAMELLAE moderately close, L = 19–25, l = 2–3, emarginate and attached with small tooth, well-developed, intervenose, pale cream with concolorous pubescent edge. STIPE 40–60 × 0.75–1.25 mm, cylindrical, slightly broadened at apex and at base, insititious, longitudinally striate, pale brownish at apex, through brown (7E7) to dark brown (7F7) towards base, entirely covered with hairs concolorous with pileus centre or slightly paler. CONTEXT membranaceous, without any special smell. RHIZOMORPHS absent.

BASIDIOSPORES 8.5–10 × 4.0–5.0(–5.25) µm, average = 9.3 × 4.6 µm, E = 1.8–2.2, Q = 2.0, fusoid-ellipsoid, lacrimoid, thin-walled, non-dextrinoid. BASIDIA e.g. 31 × 9.5 µm, 4-spored, clavate. BASIDIOLES up to 35 × 3.0–10 µm, fusoid, clavate, cylindrical. CHEILOCYSTIDIA 17–32 × 4.0–7.0 µm, clavate, subcylindrical, irregular or mostly with 1–3(–4) large projections at the top, thin- to rarely slightly thick-walled, hyaline. PLEUROCYSTIDIA scattered, 34–42 × 7.5–9.5 µm, clavate, thin-walled, originating in subhymenium, with slightly refractive contents. TRAMA HYPHAE ± cylindrical, thin-walled, hyaline, non-dextrinoid, up to 8.0 µm wide. PILEIPELLIS a cutis of radially arranged, cylindrical or inflated, thin- to slightly thick-walled, non-dextrinoid, up to 10 µm wide hyphae with (sub)hyaline to pale ochraceous walls in KOH. PILEUS HAIRS cylindrical, thick-walled (walls up to 2.5 µm thick), acute or subacute, septate, at base curved or ± irregular, up to c. 700 × 3.0–7.0 µm, dextrinoid with walls yellow-brown in H_2O and olivaceous in KOH; mixed with short, fusoid, cylindrical, regular or irregular, ± weakly dextrinoid cells. STIPITIPELLIS a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0 µm wide hyphae with walls yellow-brown in H_2O and brightly olivaceous

in KOH. Stipe hairs similar to pileus hairs, c. 70–500 × up to 8.0 µm, obtuse to subacute, more or less (scattered) septate, thick-walled (walls up to 2.5 µm thick), with a non-obliterated lumen, dextrinoid, walls yellow-brown in H_2O and brightly olivaceous in KOH. Clamp connections present in all tissues.

Habitat — On rhizomes of a plant (*Petasites*?) in open woodland with *Pinus densiflora*.

Locality — Republic of Korea, Jeju, Udo Island, 33° 29' 34" N, 126° 57' 53" E, alt. 90 m, 4 July 2008, leg. V. Antonín 08.55 and R. Ryoo (holotype, BRNM 712570).

Remarks — *Crinipellis rhizomaticola* is characterised by a rather large, chestnut-brown pileus, moderately large basidiospores, clavate, subcylindrical cheilocystidia that are irregular or have 1–3(–4) large projections at apex, and well-developed pleurocystidia. Having olivaceous coloured hairs in KOH, it belongs to sect. *Grisentinae* (Singer 1976, 1986).

Among species with well-developed pleurocystidia, *Crinipellis alcalivirens* has a smaller, 6–12 mm broad, differently shaped pileus, a shorter stipe (12–14 × 0.6–0.8 mm), smaller basidiospores (7.5–8.5 × 4.5–5.7 µm), narrowly ventricose, subfusoid or ampullaceous pleurocystidia, and grows on monocotyledons. *Crinipellis trichialis*, also growing on monocotyledons, has a smaller, only 2–7 mm broad pileus, a distinctly shorter stipe (3–9 × 0.3–1 mm), and broader basidiospores (7.3–9.7(–10.2) × 4–6.7 µm). Among species growing on dicotyledons, *C. sapindacearum* has a smaller pileus (3–5 mm broad), shorter stipe (9–14 × 0.4–0.5 mm), smaller basidiospores (7.5–8.2 × 3–6.5 µm) and cheilocystidia in the form of broom cells, and *C. tucumanensis* a smaller, only 4–13 mm broad, fulvous brown pileus, a shorter stipe (13–36 × 0.3–1 mm) and smaller basidiospores (5.5–8.5 × 4–6 µm) (Singer 1976). The African species *Crinipellis pseudosplachnoides* (Henn.) Pat. differs especially by a smaller, 7–15 mm broad, pale brown pileus, a shorter stipe (10–40 × 1–2 mm), larger (42–65 × 5–6 µm), and cylindrical clavate pleurocystidia (Pegler 1977) and *C. glaucospora* (Beeli) Pegler by a reddish brown pileus, a shorter (10–25 × 1–1.5 mm), deep reddish brown stipe, smaller basidiospores (6–8.5 × 3.2–4 µm), differently shaped cheilocystidia, and shorter (21–24 × 4–5.5 µm), sinuous-fusoid, and mostly pointed pleurocystidia (Pegler 1966). *Crinipellis scabella* has smaller basidiocarps with paler, orange- to red-brown pileus hairs on paler cream white background, broader basidiospores ((6.5–)7.5–9.5(–10.5) × (4.0–)4.5–6.0(–8.0) µm), and differently shaped cheilocystidia (Antonín & Noordeloos 1997, 2009).

Crinipellis zonata (Peck) Pat. Fig. 3

NCBI accession number FJ588911

Basidiocarps single or in groups. Pileus 8–27 mm broad, conical or convex-conical with a distinctly to obtusely umbonate centre with central umbilicus

and inflexed margin when young, convex or applanate with papilla on distinct umbo and inflexed margin when old, entirely sparsely tomentose, with (yellowish) chestnut-brown zones when young, then dark brown. Lamellae well-developed, slightly crowded, L = 40–48, l = (0–)1, attached with small tooth, pale cream with concolorous edge. Stipe 30–56 × 1–2 mm, cylindrical, slightly broadened at base, insititious, entirely distinctly hairy, longitudinally striate, pale brownish at apex, through brown to dark brown towards base. Spore print white.

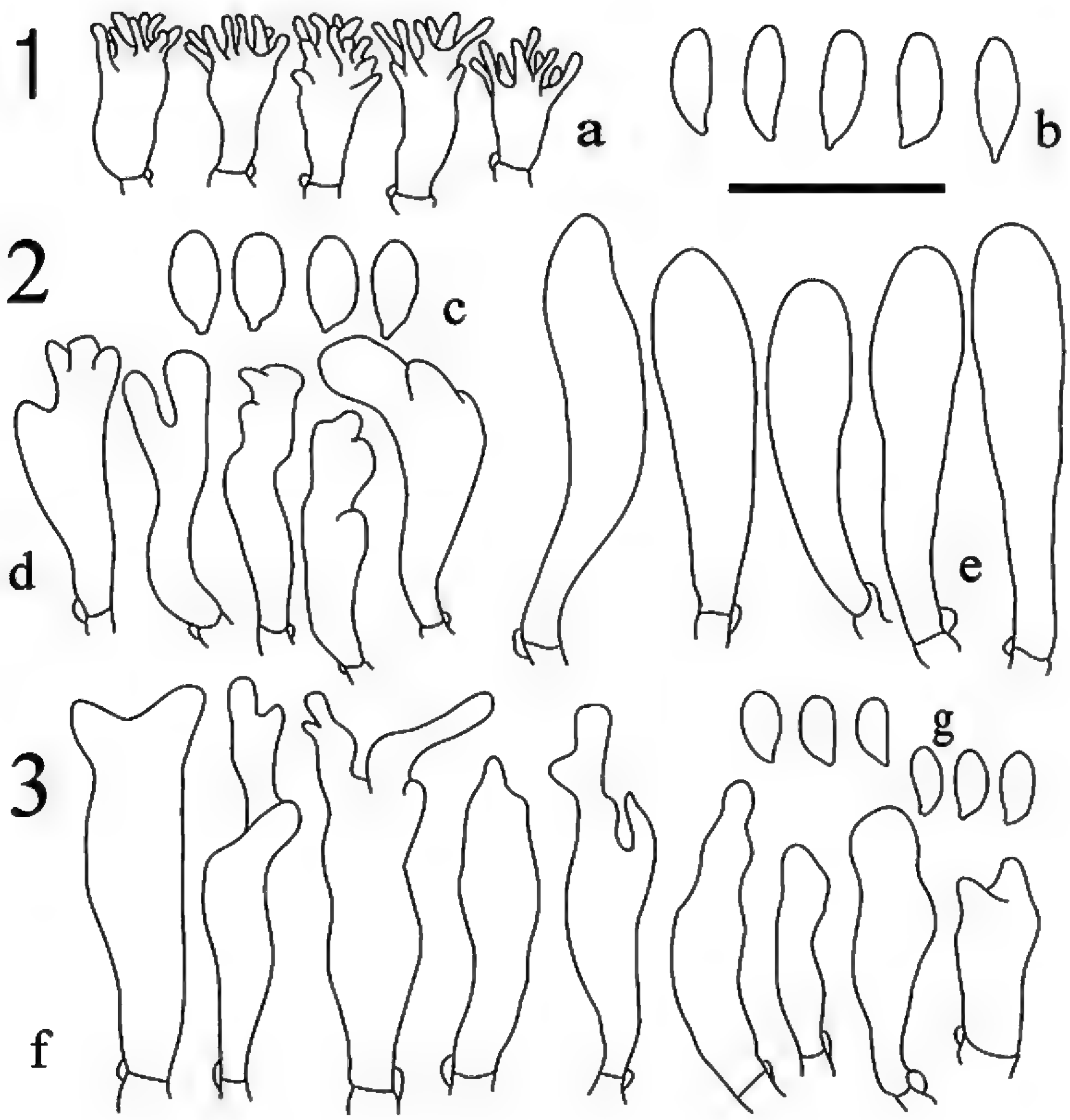
Basidiospores 6.5–7.25 × 3.0–4.0 µm, average = 6.8 × 3.5 µm, E = 1.5–2.3, Q = 2.0, (fusoid-)cylindrical-ellipsoid, thin- to slightly thick-walled, smooth, both dextrinoid and non-dextrinoid. Basidia 25–30 × 6.0–6.5 µm, 4-spored, clavate. Basidioles 15–28 × 3.0–8.0 µm, clavate, cylindrical or fusoid. Cheilocystidia 20–45 × 5.0–9.0 µm, cylindrical, clavate or fusoid, irregular, branched or subcoralloid, thin- to slightly thick-walled, non-dextrinoid. Pleurocystidia absent. Trama hyphae cylindrical to subinflated, thin- to slightly thick-walled, non-dextrinoid, up to 20 µm wide. Pileipellis a cutis of ± radially arranged, cylindrical to subinflated, ± slightly thick-walled, non-dextrinoid, smooth, up to 10(–15) µm wide hyphae. Pileus hairs c. 50–800 × 4.0–10 µm, cylindrical with irregular base, obtuse, septate, dextrinoid, with walls yellow-brown in H_2O and KOH; mixed with smaller, irregularly clavate, fusoid or cylindrical, less distinctly dextrinoid cells. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, non-dextrinoid, up to 4.0 µm wide hyphae. Stipe hairs similar to pileipellis hairs. Clamp connections present in all tissues.

Habitat — On twig of deciduous tree.

Locality — Republic of Korea, Hongcheon, Dong-myeon, Deokchi-ri, 37° 41' 57.84" N, 127° 57' 28.32" E, alt. 181 m, 28 Aug. 2008, leg. R. Ryoo KG 253 (BRNM 712579).

Remarks — *Crinipellis zonata* is characterised by having rather robust basidiocarps with a brown coloured pileus and stipe hairs, rather small basidiospores, well-developed cylindrical, clavate or subfusoid, irregular to apically branched cheilocystidia, and by the absence of pleurocystidia. It belongs to sect. *Crinipellis* (Singer 1976, 1986).

Our collection agrees well with the description of *C. zonata* by Redhead (1989), including the attachment of the stipe base. The only difference is in size and shape of the basidiospores, which are larger (4.8–8 × 3.8–5 µm) and broadly ellipsoid to subglobose in his description. However, Doyle (1987) described basidiospores as (5.8–)6.2–7.6(–8.5) × 3.6–4 µm. Basidiospores in our collections were often (fusoid-)ellipsoid but some of them were almost distinctly cylindrical-ellipsoid. However, this character falls within the variability of this taxon.



FIGS. 1–3. FIG. 1. *Crinipellis nigricaulis* var. *macrospora*; a. cheilocystidia, b. basidiospores; FIG. 2. *Crinipellis rhizomaticola*; c. basidiospores, d. cheilocystidia, e. pleurocystidia; FIG. 3. *Crinipellis zonata*; f. cheilocystidia, g. basidiospores.
Scale bar = 20 µm

According to Redhead (1989), *Crinipellis cremoricolor* represents only a variety of *C. zonata* with a cream to cartridge buff pileus and a stipe and pale pinkish cinnamon lamellae, named *C. zonata* var. *cremoricolor* (R.L. Schaffer & M.G. Weaver) Redhead. *Crinipellis zonata* is only known from North America (Canada, USA; Doyle 1987, Redhead 1989) and Europe (Portugal; Antonín & Noordeloos 1997, 2009) to date.

Phylogenetic analysis

Based on ITS rDNA sequences obtained in this study and from GenBank, the phylogenetic placement and relationship of the three species of *Crinipellis*

collected in the Republic of Korea were inferred from MCMC and MP analyses. Eighteen sequences were aligned to create a dataset. For MCMC inference, all five analyses resulted in the same tree topology and almost identical PPs. The phylogenetic tree produced is shown in Fig. 4. Of the 639 total characters, 149 were parsimony-informative, and MP analysis produced 13 MP trees of 258 steps with a consistency index of 0.8682 and a retention index of 0.9272. Since no difference was found between the tree topologies from the two analyses, only a MCMC tree is shown.

The investigated sequences were divided into two distinct groups, A and B, which were strongly supported by high reproducibility values (MCMC PP/MP BS) of 1.00 / 100 % and 0.99 / 94 %, respectively. Clade A includes the sequences deposited as *Moniliophthora perniciosa, M. roreri, Crinipellis roreri* var. *roreri* (and var. *gileri*), and *C. brasiliensis*, whereas clade B includes those of *C. nigricaulis* (and

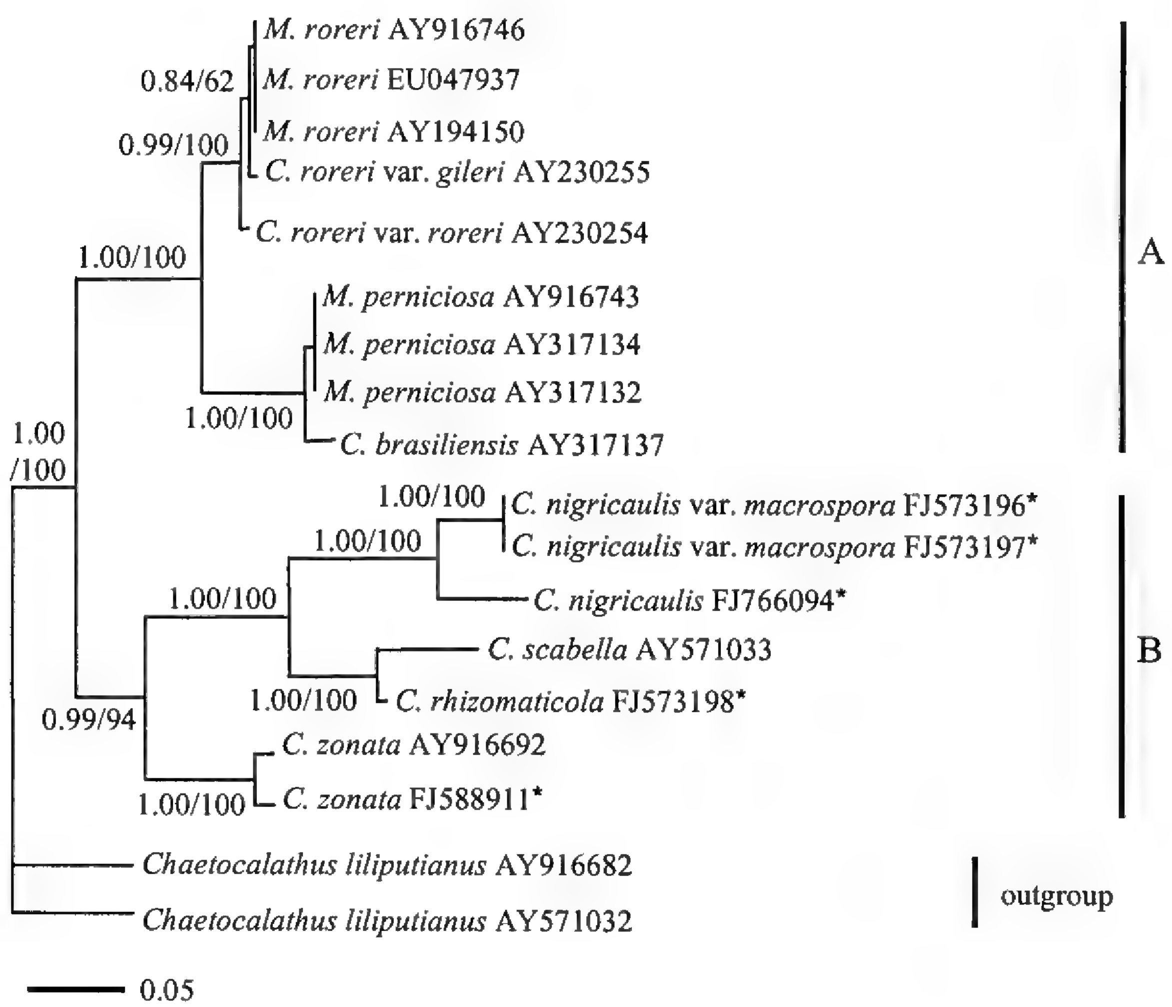


Fig. 4. Phylogenetic tree of *Crinipellis* sensu lato including *Moniliophthora* species based on the complete ITS rDNA region (ITS1, 5.8S rDNA, and ITS2), showing mean branch lengths of a 50 % majority-rule consensus tree from a MCMC analysis. MCMC PP / MP BS values are given above the supported node. The scale bar equals the number of nucleotide substitutions per site. An asterisk (*) denotes taxa sequenced in this study.

var. *macrospora*), *C. scabella*, *C. rhizomaticola*, and *C. zonata*. Clade B represents the genus *Crinipellis* as it includes the type species of the genus, *C. scabella*. In the ITS-based tree, the three Korean taxa — *Crinipellis nigricaulis* var. *macrospora*, *C. rhizomaticola*, *C. zonata* — form three distinct branches in clade B. The specimens of *C. nigricaulis* var. *macrospora* form a group with the type specimen of *C. nigricaulis*, but shows 29 base substitutions with the latter taxon, supporting the introduction of a new variety for the former. Although two sequences of *C. nigricaulis* and *C. nigricaulis* var. *macrospora* show a high nucleotide difference, they share many morphological characters and habit. They show minor differences in the sizes of basidiospore and cheilocystidia. The ITS sequences of *C. rhizomaticola* and *C. scabella* form a subgroup with high supporting values (1.00 / 100), but a sequence divergence of 3.4 % (22 out of 639 nucleotide characters were different) was found between them. Compared with a sequence (AY916692) of *C. zonata* retrieved from GenBank, the Korean material showed six base substitutions in ITS rDNA, but they clustered to a well-supported group (1.00 / 100).

Discussion

In the ITS-based analysis, the grouping of the members in clade A was similar to previous works indicating the close phylogenetic affinities of *Moniliophthora roreri* var. *roreri* and var. *gileri* (as *Crinipellis roreri* var. *roreri* and var. *gileri*) (Evans et al. 2003) as well as *C. brasiliensis* and *M. perniciosa* (as *C. perniciosa*) (Arruda et al. 2005). The clade B result also agreed well with the monophyletic *Crinipellis* clade indicated by Aime & Phillips-Mora (2005). The ITS phylogeny does not seems to be consistent with previous morphology-based sections of *Crinipellis*; *C. rhizomaticola* and *C. scabella*, placed respectively in sections *Grisentinae* and *Crinipellis* are phylogenetically closer than are *C. nigricaulis* var. *macrospora* (sec. *Grisentinae*) and *C. zonata* (sec. *Crinipellis*).

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A checklist of the Brazilian gasteroid fungi (*Basidiomycota*)

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Abstract — Based on the available literature, a list of 232 gasteroid species recorded from Brazil since the earliest known collection is presented. These species are distributed among 54 genera and 16 families (plus incertae sedis). *Morganella fuliginea*, *Calvatia cyathiformis*, *Geastrum saccatum*, *Scleroderma albidum*, and *S. verrucosum* are the species with widest distribution in Brazil. Rio Grande do Sul is the State with the largest recorded gasteroid mycota. The complete checklist is available on http://www.mycotaxon.com/resources/weblists.html.

Key words — gasteromycetes, mycodiversity, Brazilian fungi

Introduction

Brazilian mycota studies started in 19th century with European naturalists' interest. Many foreign travelers were collectors and sent materials to scientists in different countries in Europe who identified the specimens (Fidalgo 1968).

Concerning the gasteromycetes, the first collection from Brazil was a *Clathrus* specimen gathered in 1826 by William John Burchell (Fidalgo 1974). Other foreigners who contributed to gasteroid fungi knowledge in the country were: Berkeley (Berkeley 1842, Berkeley & Cooke 1876), Möller (1895), Hennings (1902, 1904a, b, c), Lloyd (1906a, b, c, d, 1907a, b, c), Sydow & Sydow (1907), Patouillard (1907), and Rick (1930, 1961).

It was about the middle of the twentieth century that some Brazilian scientists began working with gasteroid fungi taxonomy (Silveira 1943, Batista 1950, Batista & Vital 1955, 1957, Batista & Bezerra 1960), but only at the beginning of the new millennium that detailed studies concerning the group started (Baseia & Milanez 2000, 2001a, b, 2002a, b, c, 2003a, b).

Gasteroid fungi present a wide range of basidiomata structure and these distinctive life forms led to the designation of many genera represented by only one or a few species. Currently, approximately a hundred genera of gasteromycetes are accepted (Dring 1973, Miller & Miller 1988).

The main objective of this article is to compile data about Brazilian gasteroid fungi and present a list of species.

Material and methods

This checklist is based on intensive search of literature records of gasteroid fungi recorded from Brazil. Nomenclature and author names follow Index Fungorum (IFS—http://www.indexfungorum.org/Names/Names.asp) and the International Plant Names Index (IPNI—http:// www.ipni.org). Genera and species are listed alphabetically inside each family according to Kirk et al. (2008). Genera with taxonomic positions not well established are designated as 'incertae sedis'. Names not found on the IFS database are marked with *. This checklist includes only records that were identified to the species level.

Although this compiled list has been reviewed carefully, minor errors can occur. We plan to regularly update the internet version of the checklist, so we gratefully encourage any remarks concerning errors or omitted data.

Results

The 232 gasteroid fungi species recorded from Brazil are distributed among 54 genera and 16 families. The most highly represented family is *Agaricaceae* with 104 species (44.8 %), followed by *Geastraceae* and *Phallaceae* (with 44 and 38 species, respectively). *Geastrum* is the genus with the highest number of species, with 40 taxa (17.2 %).

The species with widest Brazilian distribution are *Morganella fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring (recorded from 7 States), followed by *Calvatia cyathiformis* (Bosc) Morgan, *Geastrum saccatum* Fr., *Scleroderma albidum* Pat. & Trab. and *S. verrucosum* (Bull.) Pers. (6 States). Rio Grande do Sul is the State with the greatest number of gasteroid mycota recorded (133 taxa/57.3 %), especially due to the great contribution of Father Johannes Rick.

If there are approximately a hundred genera of gasteromycetes (Dring 1973, Miller & Miller 1988), the diversity of this group is still not well represented in Brazil, since only 54 genera are recorded in the literature.

The complete checklist of the Brazilian gasteroid fungi is available on http:// www.mycotaxon.com/resources/weblists.html.

Acknowledgments

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A new species of *Hohenbuehelia* from China

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Abstract — *Hohenbuehelia olivacea* from China is described as new to science.

Key words — *Basidiomycota, Pleurotaceae,* taxonomy

Introduction

The genus *Hohenbuehelia* was established by Schulzer (Schulzer et al. 1866), and it belongs to the family *Pleurotaceae* (Kirk et al. 2001). The main characteristics of the genus are small to large basidiomata, gills that are decurrent or radiate from a point of central or lateral attachment on the under side of the cap, sessile or stipitate with a lateral pseudostipe (rarely a central stipe), a gelatinous zone often forming below the cap cuticle, monomitic and clamped hyphae, thick-walled metuloids, fusiform cheilocystidia, and commonly with an hour-glass secretory cell surrounded by a mucous droplet at the tip of a short or elongated neck (Thorn 1986, Corner 1994).

In earlier studies (Teng 1963; He 1992; Bi et al. 1993, 1997; Chang & Mao 1995; Mao 1998; Chang et al. 2001; Li & Bau 2003), eleven taxa representing *Hohenbuehelia* have been recorded in China. Recently, an additional new species was discovered during the research on the genus based on morphological examinations of collections.

Materials and methods

Specimens were examined with traditional taxonomic methods. KOH solution and Melzer's reagent were used as the mountants when examining the microstructure. Morphological characteristics of the species were described and illustrated according to the observation of the materials. Colour descriptions for

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the new species refer to Ridgway (1912). The specimen studied is now housed in the Herbarium of Mycology of Jilin Agricultural University (HMJAU).

Taxonomy

Hohenbuehelia olivacea Yu Liu & T. Bau, **sp. nov.** FIG. 1

MYCOBANK MB 513041

Pileus 20–35 mm latus, reniformis ad dimidiatus, flavirens vel fulvus,margine galbinus vel olivaceus, strigosus, strigis olivaceis prope basem. Lamellae decurrentes, flavae, crebrae. Stipes nullus. Basidiosporae (6–)6.5–7.5(–8) × (3–)3.5–4 µm, ellipsoideae. Basidia 25–31 × 5.5–6.5 µm, clavata, 4-sporigera. Cheilocystidia 25–32 × 5–7 µm, clavata, vel ventricoso-fusiformia, saepe capitulata. Metuloidae 52–65 × 9–13 µm, sublanceolatae vel subfusoideae, apice incrustatae. Pileipellis ex hyphis 3–4 µm crassis, repentis vel ascendentis. Superficies pilei sine cystidis.

HOLOTYPE: China, Jilin Province, Lushuihe Town, 30 June 2005, Tolgor Bau, HMJAU 7290.

ETYMOLOGY: The species epithet *olivacea* refers to its pileus colour.

BASIDIOMATA small to middle-sized, reniform or dimidiate, sessile. PILEUS 20–35 mm broad, pale yellow-brown to olive, with dense and long tomentum, strigose and slate-"olive" colour towards the base, finely and shortly tomentose and pale "yellow green" or olive at margin when dry. CONTEXT thin, white to brownish. GELATINOUS ZONE obviously visible, light brown to pallid brown, glossed. LAMELLAE "pallid yellow", narrow and moderately close, thin, decurrent. STIPE absent or sometimes covered with white mycelium at the base. SPORE PRINT white.

BASIDIOSPORES ellipsoid, (6–)6.5–7.5(–8) × (3–)3.5–4 µm, average 6.93 × 3.63 µm, Q = 1.86–2.00, average = 1.94, smooth, hyaline, colourless, thin-walled, multiguttulate. BASIDIA 25–31 × 5.5–6.5 µm, clavate, with four short sterigmata 1.5–2 µm long. CHEILOCYSTIDIA 25–32 × 5–7 µm, subclavate, fusoid-ventricose to clavate-capitate, thin-walled, hyaline, with a globular mucous droplet at the tip of a short or elongated neck; the droplet 2.5–3 × 5–7 µm, thick-walled, glossy, becoming hour-glass secretory cell when mature. METULOIDS sublanceolate, cyprinoid or fish-fusiform shape, 52–65 × 9–13 µm, gradually enlarged upwards and then with a sharp apex, pale yellow, thick-walled, and crystal-encrusted (about 1/5–1/4) at apex, becoming thinner at the base, implanted into hymenium. LAMELLAR TRAMA hyphae parallel, 3–5 µm diam., sometimes inflated to 6–8 µm diam., smooth, hyaline, branched, clamped. PILEIPELLIS hyphae 3–4 µm diam., thin-walled to thick-walled, smooth, clamped, forming fascicles arranged on the cuticle as a network, branches and tomentum. GELATINOUS ZONE composed of hyphae in 1.5–3 µm diam., colourless, lax and implicated, often with inflated nodes or clamp connections in the middle of hyphae; hyphal terminals occasionally visible, inflated, thin-walled, hyaline,

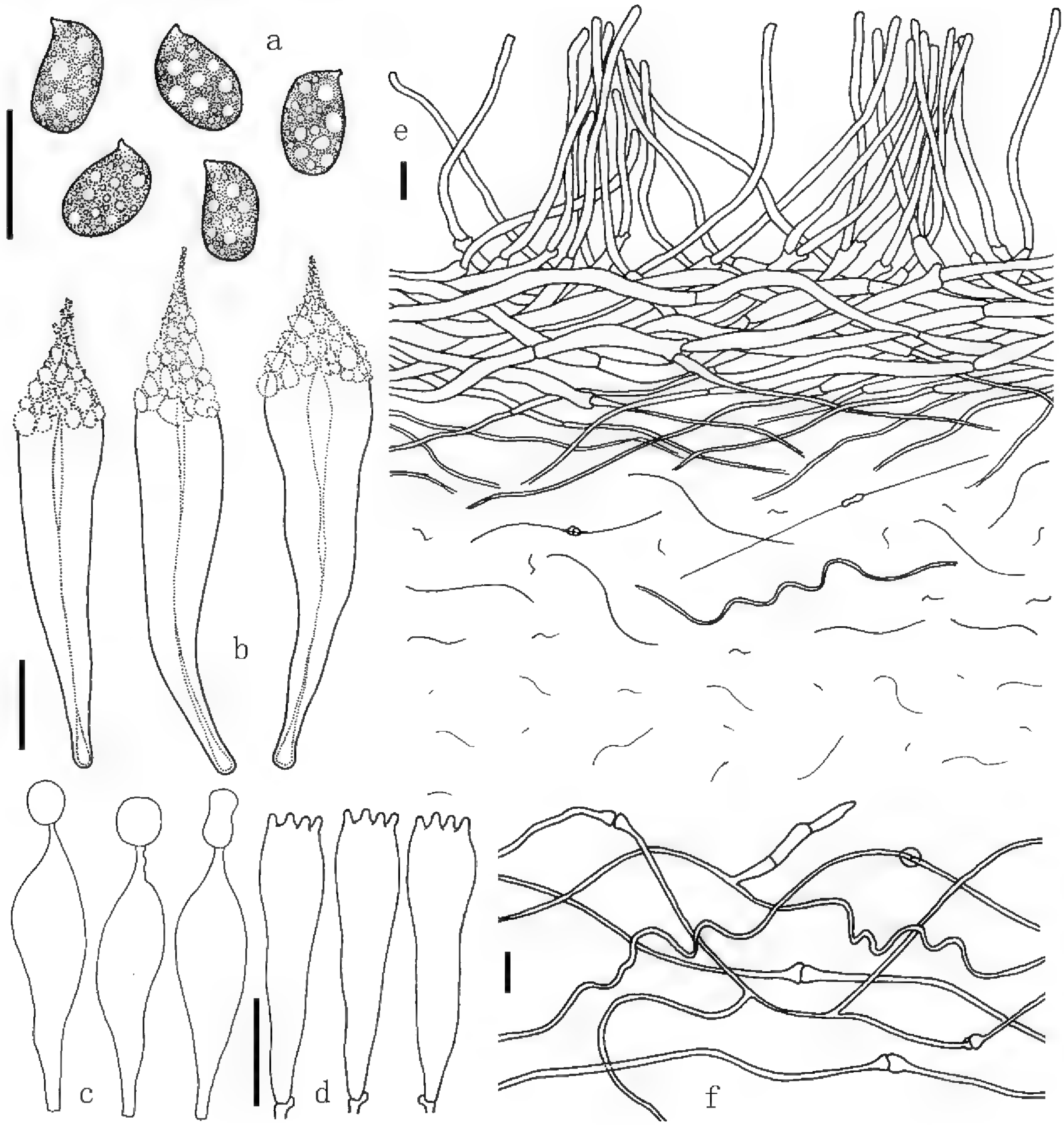

Fig. 1. *Hohenbuehelia olivacea* (HMJAU 7290) (bar = 10µm)
a: Basidospores b: Basidia c: Cheilocystidia d: Metuloids
e: Pileipellis f: Gelatinous zone hyphae

multiseptate, cylindrical or moniliform. Flesh hyphae 4–6 µm diam., thin-walled, hyaline, smooth, sinuous.

Habit—Caespitose on rotten-wood of a broad-leaf tree in mixed forest.

Remarks— This species is similar to *H. reniformis* (G. Mey.) Singer in having a tomentose pileus and short, stout sterigmata but differs from the latter in its slate-olive tomentum on the pileus and the lack of pileocystidia. Moreover, the metuloids of the new species are sublanceolate or cyprinoid, with a sharp apex.

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A new species of *Pyricularia* on *Commelina communis*

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Abstract — *Pyricularia commelinicola* sp. nov., causing circular leaf spots, was found on *Commelina communis* in Korea. The fungus is described, illustrated, and compared with the previously known *Pyricularia* species on the genus *Commelina*. The phylogenetic relationship of the fungus with other *Pyricularia* species is discussed.

Key words — blast, *Pyricularia oryzae* var. *commelinae*, *Magnaporthe*, anamorphic fungi, phylogeny

Introduction

Members of the genus *Pyricularia* (anamorphic *Magnaporthe*) cause blast disease, mostly on monocotyledonous plants. Of the approximately 70 taxa in the genus, *P. grisea* Sacc. and *P. oryzae* Cavara are the best known species. They occur on family *Poaceae* and were originally described on *Digitaria sanguinalis* and *Oryza sativa*, respectively. Many other species are associated with host plants belonging to especially *Cannaceae*, *Commelinaceae*, *Cyperaceae*, *Musaceae*, and *Zingiberaceae*. The taxonomy of *Pyricularia* species has been based mainly on host range and morphology of conidia, conidiophores, and appressoria. Recently, molecular analysis of DNA sequence data has become important in the study of the genus. The morphological similarity of *P. grisea* and *P. oryzae* has caused taxonomic controversy as to whether the two taxa are synonymous (e.g. Rossman et al. 1990). The incompatible results of mating experiments (Hebert 1971, Yaegashi & Udagawa 1978, Kato et al. 2000) have made it more difficult to resolve the taxonomic problem. Nevertheless, molecular analyses (Borromeo et al. 1993, Kato et al. 2000) have provided evidence for genetic separation of the two taxa. A significant contribution to the taxonomic resolution came from the multilocus genealogical approach of Couch & Kohn (2002), although to some

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Table 1. Sequence data used in the molecular analysis

Species	Host Species	Isolate No	GenBank No
Pyricularia angulata	*Musa sapientum*	NBRC9625	AY265322
Pyricularia costina	*Alpinia malaccensis*	ICMP14609	AY265329
Pyricularia grisea	*Digitaria sanguinalis*	MAFF240217	AB274428
Pyricularia grisea	*Digitaria sanguinalis*	MAFF240218	AB274429
Pyricularia grisea	*Digitaria horizontalis*	MAFF240210	AB274430
Pyricularia higginsii	*Microlaena avenacea*	ICMP14620	AY265325
Pyricularia higginsii	*Microlaena avenacea*	ICMP14707	AY265326
Pyricularia juncicola	*Carex* sp.	ICMP14625	AY265320
Pyricularia juncicola	*Uncinia* sp.	P17	AY265321
Pyricularia oryzae	*Oryza sativa*	MAFF235005	AB274418
Pyricularia oryzae	*Oryza sativa*	MAFF235006	AB274419
Pyricularia oryzae	*Oryza sativa*	MAFF235003	AB274420
Pyricularia oryzae	*Oryza sativa*	PO-02-7306	AB274421
Pyricularia oryzae	*Setaria italica*	MAFF240214	AB274422
Pyricularia oryzae	*Eleusine coracana*	MAFF240215	AB274423
Pyricularia oryzae	*Eleusine coracana*	MAFF240216	AB274425
Pyricularia oryzae	*Avena sativa*	MAFF240213	AB274424
Pyricularia zingiberis	*Zingiber mioga*	MAFF240222	AB274433
Pyricularia zingiberis	*Zingiber mioga*	MAFF240223	AB274434
Pyricularia zizaniicola	*Zizania latifolia*	MAFF240219	AB274431
Pyricularia zizaniicola	*Zizania latifolia*	MAFF240220	AB274432
Pyricularia commelinicola	*Commelina communis*	KACC43081	FJ850122*
Pyricularia commelinicola	*Commelina communis*	KACC43869	FJ850123*
Pyricularia commelinicola	*Commelina communis*	KACC43966	FJ850124*
Pyricularia commelinicola	*Commelina communis*	KACC44083	FJ850125*

* Sequences obtained in the present study

extent debate and confusion over the taxonomic status of the two species still remain. Recently, Hirata et al. (2007) emphasized that combining morphological or biological species criteria with a phylogenetic species concept is required to determine current species delimitation in *Pyricularia*.

During extensive surveys of phytopathogenic fungi in Korea, symptoms of circular zonate leaf spots were observed on *Commelina communis*. The presence of the typical pyriform conidia placed the fungal pathogen unambiguously in *Pyricularia*. We compared the fungus morphologically with three *Pyricularia* taxa recorded on other *Commelina* species and molecularly analyzed the ITS rDNA region to clarify phylogenetic relationships among the present fungus and other *Pyricularia* species for which ITS sequence data were available from GenBank. On the basis of morphological and molecular data, the fungus isolated from *C. communis* is considered to represent a new species of *Pyricularia*, which is described and illustrated below.

Materials and methods

Nine samples of a *Pyricularia* fungus were collected on *Commelina communis* from July to October in Korea. Fresh collections and herbarium specimens were used for morphological observation. For fresh specimens a small piece of living tissue containing fungal structures was mounted in a drop of water for microscopic examination, while dried specimens were rehydrated in 3% KOH solution and then examined. For each sample, 40–50 conidiophores and conidia were measured at a magnification of 200× and 400× using an eye-piece micrometer and an Olympus BX51 microscope (Olympus, Tokyo, Japan). Images were obtained using a Zeiss Axio imager microscope (Carl Zeiss, Göttingen, Germany).

Cultures were derived from single conidia and grown on potato dextrose agar (PDA). After four weeks, mycelia harvested from the surface of the colonies, were used for genomic DNA extraction following method of Lee & Taylor (1990). The primers ITS1 and ITS4 were used to amplify the ITS rDNA region (White et al. 1990). The obtained PCR products were purified using a QIAquick gel extraction kit (Qiagene, Valencia, CA, USA), and then directly sequenced on an ABI Prism TM 377 automatic DNA sequencer (Applied Biosystems, Foster City, CA, USA), using BigDye™ cycle sequencing kit version 3.1 (Applied Biosystems), with the same primers used for PCR. The ITS rDNA sequences were edited using the DNASTAR computer package version 5.05 (Lasergene, Madison, WI). The newly obtained ITS sequences of four isolates were deposited in GenBank, from which 21 sequences of *Pyricularia* spp. were retrieved for comparison (Table 1). A phylogenetic tree was constructed by neighbor-joining method using MEGA4 version 4.0 (Tamura et al. 2007). The relative robustness of the individual branches was estimated by bootstrapping

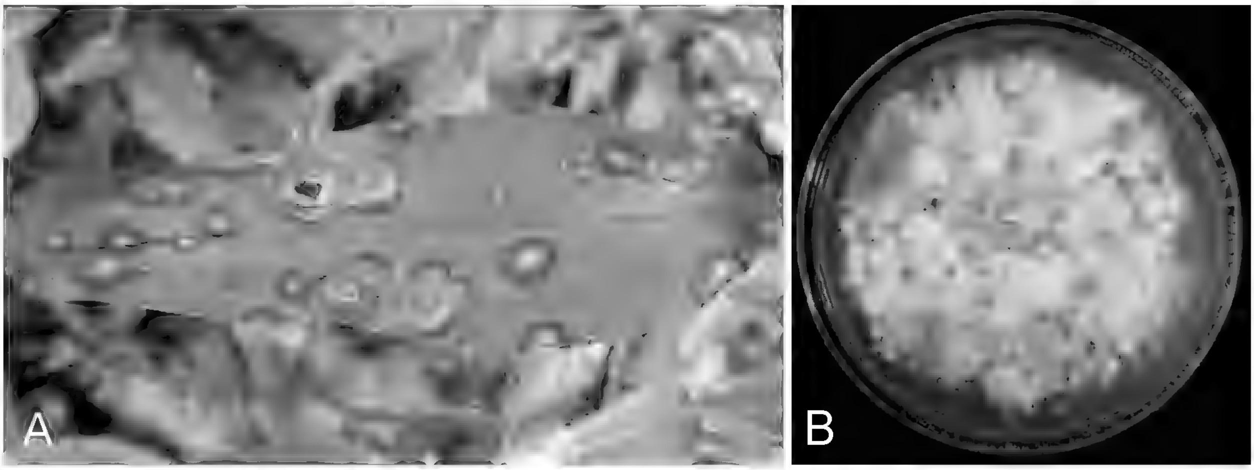

Fig. 1. A - Symptoms of *Pyricularia commelinicola* on *Commelina communis*. B - Colony of *P. commelinicola* after four weeks of incubation on PDA.

using 1000 replicates. A sequence of *Gaeumannomyces amomi* (AY265317), a member of the *Magnaporthaceae*, was used as an outgroup.

Taxonomy

Pyricularia commelinicola M.J. Park & H.D. Shin, **sp. nov.** Figs. 1–2

MycoBank MB513167

Maculae amphigenae, discretae, orbiculares vel suborbiculares, 6–10 mm diam., concentricae; ad centrum pallide brunneae vel griseae, margines brunneae vel atrobrunneae cum halores flavidae. Conidiophora hypophylla, floccosa, raro ramosa, ad 7-septata, recta vel geniculata, hyalina, laevia, 150–530 µm longa, 4–6 µm lata, ad basim 10–12 µm lata. Cellulae conidiogenae terminales vel intercalares, cylindricae, geniculatae, denticulatae; cicatrices conidiales conspicuae, leniter incrassatae, fuscatae. Conidia solitaria, piriformis vel obclavata, hyalina, laevia, 2-septata, 27–42(–45) × 10–12.5 µm, hila eminentia. Coloniae in agaro decocto tuberorum, 60 mm diam. in 14 dies ad 25°C, effusae, albae vel pallide griseae.

Holotype – On living leaves of *Commelina communis* L. (*Commelinaceae*), KOREA, Hongcheon, Bukbang-ri, 37°48'1" N, 127°51'9" E, 9 September 2007, H.D. Shin & M.J. Park, KUS-F 22838 (culture ex-type: KACC43081)

Etymology – The epithet refers to the host plant, *Commelina*.

Leaf spots amphigenous, scattered, sometimes confluent, circular to subcircular, 6–10 mm diam., zonate, centre pale brownish to grayish with brownish to dark brownish margin, often surrounded by yellow halo. Conidiophores hypophyllous, floccose, rarely branched, up to 7-septate, straight or geniculate, hyaline, smooth, 150–530 µm long, 4–6 µm thick, 10–12 µm wide at the bulbous base. Conidiogenous cells terminal or intercalary, cylindrical, geniculate, denticulate; conidiogenous scars conspicuous, slightly thickened, darkened. Conidia solitary, pyriform to obclavate, hyaline, smooth, 2-septate, 27–42(–45) × 10–12.5 µm (mean = 35.3 × 11.2 µm), length/width (l/w) ratio 2.4–4.3 (mean = 3.1), hilum protuberant. Colonies on PDA reaching 60 mm in 14 days at 25°C, effuse, whitish to pale grayish.

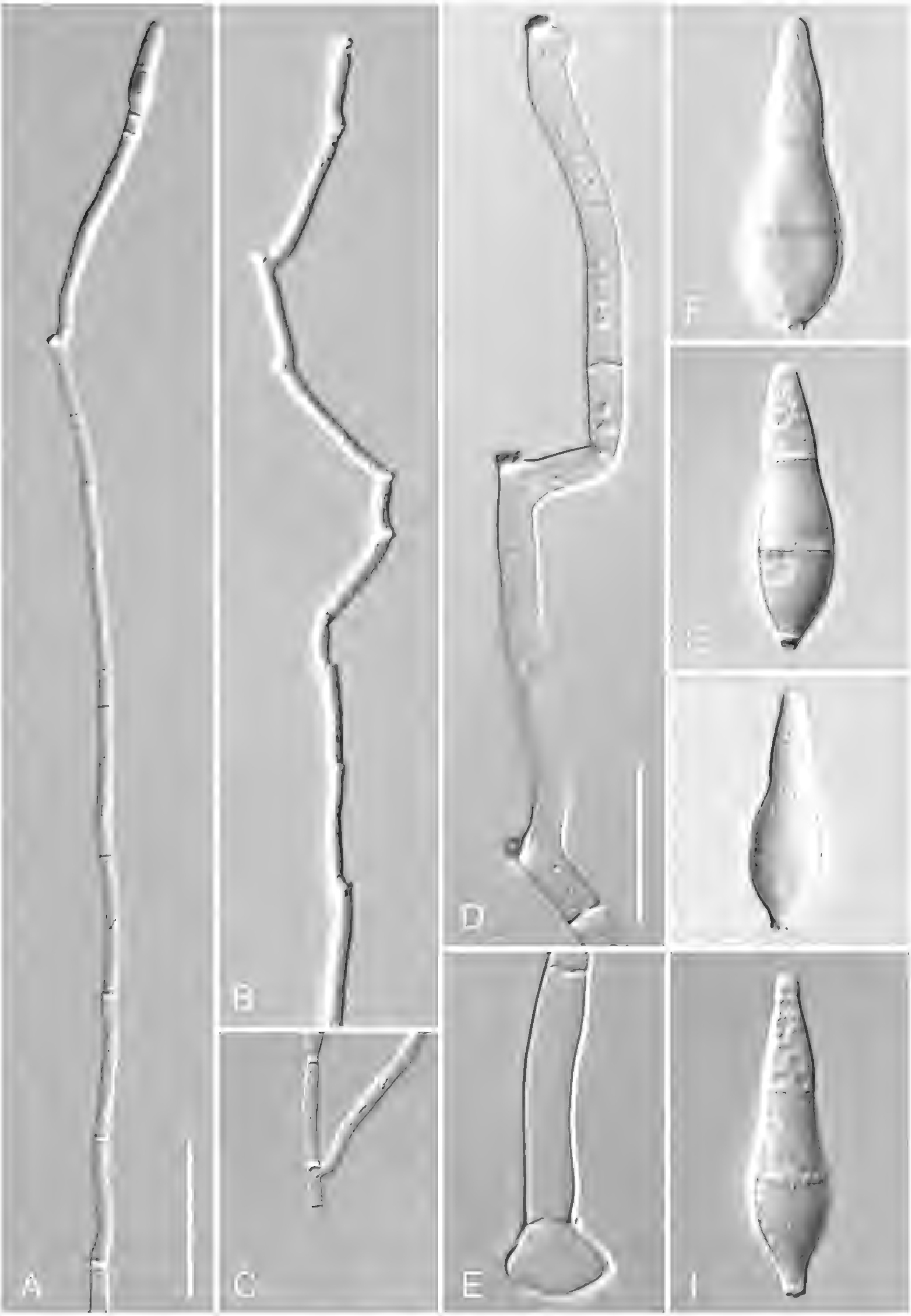

FIG. 2. *Pyricularia commelinicola*: A - Conidiophore producing an immature conidium. B - Geniculate conidiophore. C - Branched part of conidiophore. D - Apical part of conidiophore with conidiogenous scars. E - Basal part of conidiophore. F–I - Conidia.

Scale bars: A–C = 50um, D–I = 20um.

Additional Specimens Examined – Korea, Anyang, Kwanak arboretum, 37°25'8" N, 126°56'5" E, 8 October 1999, H.D. Shin, KUS-F16992; Korea, Chuncheon, Bongmyeong-ri, 37°46'49" N, 127°48'55" E, 1 October 2003, H.D. Shin, KUS-F19767; Korea, Hoengseong, Seowon-myon, 37°31'33" N, 127°52'29" E, 3 August 2007, H.D. Shin & M.J. Park, KUS-F22751; Korea, Chuncheon, Bongmyeong-ri, 37°46'49" N, 127°48'55" E, 20 August 2007, H.D. Shin, KUS-F22768; Korea, Yangpyeong, Experimental Forest of Korea University, 37°30'12" N, 127°41'55" E, 10 September 2007, H.D. Shin, KUS-F22852; Korea, Pocheon, Kookmangbong recreational forest, 38°1'2" N, 127°23'42" E, 29 July 2008, M.J. Park, KUS-F23524 (culture: KACC43869); Korea, Pyeongchang, Jinbu-myon, 37°39'40" N, 128°32'51" E, 21 September 2008, H.D. Shin & M.J. Park, KUS-F23682 (culture: KACC43966); Korea, Hongcheon, Sangoan-ri, 37°37'12" N, 127°47'5" E, 27 October 2008, H.D. Shin & M.J. Park, KUS-F23909 (culture: KACC44083).

Results and discussion

Three *Pyricularia* species have been previously reported as causal agents responsible for blast disease on four *Commelina* species: *P. ebbelsii* M.B. Ellis on *C. africana* (Ellis 1976), *P. oryzae* var. *commelinae* Thirum. et al. on *C. benghalensis* (Thirumalachar et al. 1956, Hashioka 1973), and *P. grisea* on *C. agraria* (Purchio & Muchovej 1993) and *C. erecta* (Halmos 1970).

The conidia of *P. ebbelsii* are characteristically curved and easily differentiated from those of *P. commelinicola,* which are straight. Sizes of conidia and conidiophores allow the separation of *P. commelinicola* from *P. grisea*. As described by Ellis (1971), *P. grisea* has smaller conidia (17–28 × 6–9 µm) and shorter conidiophores (up to 150 µm long) than those of *P. commelinicola* (27–42(–45) × 10–12.5 µm and 150–530 µm, respectively). *Pyricularia oryzae* var. *commelinae* is clearly distinguished from *P. commelinicola* by its smaller lesions (4–6 mm diam.), fewer septa in the conidiophores (1–2-septate), and shorter conidia (21–30 × 10–13 µm) (Thirumalachar et al. 1956). Although the conidial widths of these two species somewhat overlap, the obclavate conidia and average l/w ratio of 3.1 in *P. commelinicola* are clearly different to the relatively broadly pyriform conidia and average l/w ratio of 2.3 in *P. oryzae* var. *commelinae* (calculated from data of Thirumalachar et al. 1956).

In the present study, phylogenetic analysis of ITS rDNA sequences showed that *Pyricularia* species are separated to several distinct lineages, associated with different hosts, as shown in previous studies (Bussaban et al. 2005, Hirata et al. 2007). In the neighbor-joining tree (Fig. 3) four isolates of *Pyricularia* originating from *C. communis* formed an independent clade with bootstrap value of 100%, indicating a high possibility of them being a phylogenetic species. Unfortunately, *P. ebbelsii* and *P. oryzae* var. *commelinae*, distinguished from the present fungus morphologically, could not be molecularly compared with *P. commelinicola* because living cultures were not available. Molecular

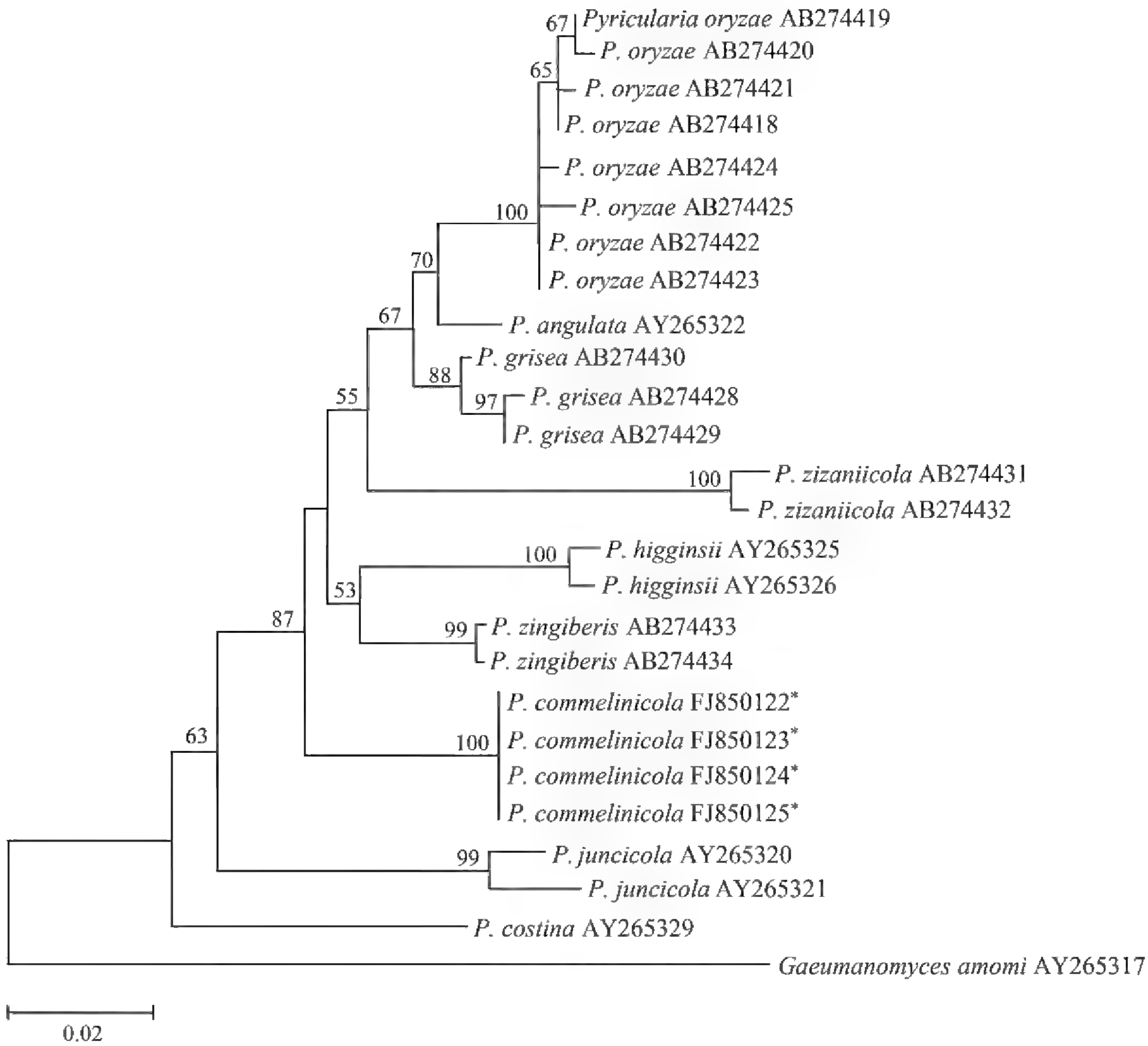

Fig. 3. A neighbor-joining tree of *Pyricularia* spp. based on the ITS rDNA sequences. Bootstrapping values greater than 50% are indicated above the braches (1000 replicates). The number of nucleotide changes between taxa is represented by branch length and a scale bar equals the number of nucleotide substitution per site. Taxa marked with asterisks(*) are sequenced in this study.

data for these two taxa are needed to infer the phylogenetic relationship with *P. commelinicola*. *Pyricularia commelinicola* is, therefore, regarded as a new species based on morphological and ITS-based molecular comparisons.

Acknowledgments

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A new species of *Phallus* from Pakistan

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Abstract — *Phallus calongei*, a new species of *Phallales* from Pakistan, is described. This new species is characterized by a white, weakly developed volva, large fusiform white to pale pinkish pseudostipe, a strongly reticulate receptacle surface with pinkish ridges, and absent indusium. Color photo and black-and-white line illustrations are provided.

Key words — *Basidiomycota, Phallaceae,* taxonomy

Introduction

The genus *Phallus* Junius ex L., typified by *P. impudicus* L., is classified in family *Phallaceae* Corda, order *Phallales* E. Fisch. (Kirk et al. 2008). Calonge (1998) characterizes this genus by the following features: "Basidioma ovoid before ripening, white, soft, with mycelial cords. Exoperidium membranous. Endoperidium gelatinous, hyaline. The rest of the peridium remains at the base like a volva. Mature pseudostipe cylindrical, hollow, white, spongy and fragile, carrying at the apex a conical receptacle, sometimes with indusium. Gleba covering the receptacle, mucilaginous, foetid, olive brown. Spores ellipsoid, pale yellowish green, smooth."

Phallus species are widespread, with basidiomata growing in rich humus soils (humid woods, gardens), littoral dunes, and fallen decaying wood. Several authors have presented comprehensive treatments of this genus. Lloyd (1909) published a synopsis of the known phalloids. Liu (1984), who included the genus *Dictyophora* Desv., recognized 15 taxa (13 species and 2 varieties) for China. Kreisel (1996) recognized 31 species of *Phallus* sensu lato (incorporating *Dictyophora*, *Aporophallus* Möller, *Itajahya* Möller, *Echinophallus* Henn., *Endophallus* M. Zang & R.H. Petersen, and several other genera). Finally, Calonge (2005) accepted 25 species and provided a provisional key.

Additional species described during the last six years include *Phallus minusculus* Kreisel & Calonge from Tanzania (Calonge & Kreisel 2002), *Phallus pygmaeus* Baseia from Brazil (Baseia et al. 2003), *Phallus atrovolvatus* Kreisel & Calonge from Costa Rica (Calonge et al. 2005), *Phallus tenuissimus* T.H. Li et al. from China (Li et al. 2005), and *Phallus maderensis* Calonge from Madeira Island, Portugal (Calonge et al. 2008).

From Pakistan, only three *Phallus* species — *P. celebicus* Henn., *P. impudicus*, *P. rubicundus* (Bosc) Fr. — have previously been reported (Ahmad 1952). With the addition of the new species proposed below, the number of *Phallus* species from Pakistan increases to four.

Materials and methods

The examined specimens come from the herbaria NY and STR. Specimens were mounted in Hoyer's medium and studied with a Nikon microscope. Spore measurements were made under the oil immersion objective.

Taxonomic description

Phallus calongei G. Moreno & Khalid, **sp. nov.** FIGS. 1–3

MYCOBANK MB 512772; GENBANK FJ785522

Ovum 25 mm diametrum, album. Basidioma maturus cum pseudostipite fusiforme, roseolo, pallido, usque ad 24 cm alto, album, spongioso. Receptaculo trunco-conico cum apice perforato, 7 cm alto et 4 cm lato, reticulato, rosado. Gleba brunneo-olivacea, foetida. Indusium nullo. Volva alba. Sporae cylindraceae, 3.5–4.5 × 1.5–2.0 µm, ellipsoidea, hyalinae. Non gregarius ad terram.

TYPE: Pakistan, North Western Frontier Province (NWFP), on ground, on way to Khanspur stream, at 2575 m a.s.l., 16th June, 2008, ANK # 169063. (**Holotype:** LAH Herbarium No. ANK 1005). **Isotype:** AH 37768.

ETYMOLOGY: *calongei*, dedicated to Prof. F.D. Calonge to honor his contribution to the study of gasteroid fungi.

Unexpanded fruitbody (egg stage) ovate, white. Basidioma up to 24 cm high (FIG. 1). Exoperidium membranous, endoperidium gelatinous, hyaline. At maturity a fusiform pseudostipe develops up to 3 cm in diam., whitish, hollow, wall consisting of layers of chambers, perforated (FIG. 2). Receptacle up to 7 cm high and 4 cm in diam., campanulate to conical-truncate with a reticulate surface, as the gleba dissipates, the receptacle surface becomes strongly reticulated, with raised pinkish ridges; apex truncated, formed by a plane, depressed and

FIGS. 1–2. *Phallus calongei* (holotype). 1. Basidioma with olivaceous dark gleba, white and fusiform pseudostipe, membranous volva. 2. Reticulated receptacle, pink, with an olivaceous green spore mass. Scale bar = 1 cm.


1
2

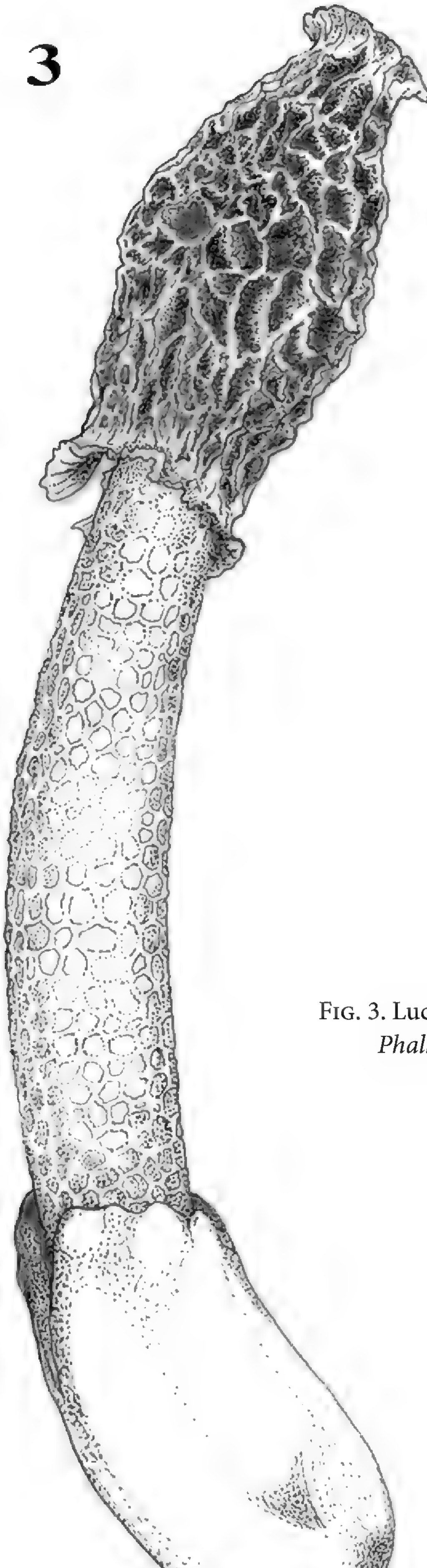

Fig. 3. Lucida drawing of basidioma of *Phallus calongei* (holotype). Scale bar = 1 cm.

perforated surface (Fig. 3). Gleba olivaceous, foetid, deliquescent. Spores 3.5–4.5 × 1.5–2.0 µm, ellipsoid, smooth, hyaline. Indusium absent. Volva consisting of a thin membrane, scarcely developed, non-perforated, white.

Discussion and conclusions

According to Kreisel (1996; pers. com. 2009), these specimens belong to the subgenus *Phallus,* section *Flavophallus* Kreisel, with six other species: *P. flavocostatus* Kreisel, *P. tenuis* (E. Fisch.) Kuntze, *P. formosanus* Kobayasi, *P. callichrous* (Möller) Lloyd, *P. multicolor* (Berk. & Broome) Cooke, and *P. cinnabarinus* (W.S. Lee) Kreisel. The proposed new species, *Phallus calongei,* is easily differentiated from the others by its scarcely developed white volva, large fusiform pure white to pale pinkish pseudostipe, a strongly reticulate receptacle surface with pinkish ridges, and absent indusium.

Only one other *Phallus* species, *P. rubicundus*, has a reddish receptacle surface and its receptacle is conical with a rugose surface. Other described species lacking an indusium and with pinkish tones include *P. formosanus*, with a pale pinkish pseudostipe and volva; *P. macrosporus* B. Liu et al., with a reddish volva, and *P. hadriani* Vent., with a purple volva.

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Lichen species new to Turkey and Asia

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Abstract—Three species of lichenized fungi – *Lecania spadicea, Opegrapha subelevata* and *Physconia isidiigera* – are new to Turkey. *P. isidiigera* is also new to Asia.

Keywords — *Ascomycota*, biodiversity, Konya, Uşak, Heybeliada

Introduction

Studies on the lichen flora of Turkey are not as extensive as elsewhere, and so the lichen flora is relatively poorly known. Recently, however, many new lichen taxa have been recorded for Turkey (Candan & Özdemir Türk 2008, Yazici et al. 2008a,b, Yazici & Aptroot 2008). Three species new to Turkey are described below.

Materials and methods

The present report is based on collections from three different provinces (Konya, İstanbul and Uşak) made between 15–20 August 2007. Air-dried lichen samples were examined using stereo and light microscopes. Secondary metabolites were identified by the usual spot tests (Brodo et al. 2001; Esslinger 1994, 2000; Mayrhofer 1988;, Purvis et al. 1992; Torrente & Egea 1989). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Karadeniz Technical University, Trabzon, Turkey (KTUB).

Species

Lecania spadicea (Flot.) Zahlbr.

Specimen examined: Konya: Seydişehir, main roadside to Seydişehir, 37°28’20”N, 31°49’30”E, on calcareous rock, 1130 m, 15 August 2007, Yazici 1557.

Thallus crustose, endolithic, effigurate, roughly leafy, to (2–)3 cm in diam., brown to dark brown. Apothecia numerous, to 1.5(–1.8) mm in diam., adpressed, sessile; disc sometimes convex, brown to red-brown or dark brown and slightly white pruinose. Thalline exciple swollen.

Hymenium 50–80 µm tall; epithecium orange to red-brown, epithecial pigment diffuse in hymenium. Paraphyses simple, gradually widening at apices, long, slightly clavate at apices with brown pigment. Asci 8-spored, *Bacidia*-type, ascospores colourless, 2-septate, thin-walled, sometimes slightly curved, 10–14 × 3–6 µm.

A mediterranean lichen, found on inclined calciferous rocks; especially common on walls in small urban areas.

Collection site — The climate is continental with hot dry summers and cold snowy winters, with a mean annual rainfall of 750 mm and mean annual temperature of 11–12 °C. The roadside locality lies near poor forests in a well lit, extensive-plain surrounded by mountains. Mean annual rainfall is 750 mm while annual temperature is 11–12°C.

Known distribution: Europe (Greece: Crete, Kerkira Islands; France, Germany, Italy), Egypt, Syria, Thailand. New to Turkey.

Remarks – *Lecania spadicea* is similar to *L. aipospila,* but in *L. aipospila* the surface is smooth and coarsely knobby warted to papillate while *L. spadicea* has an effigurate to roughly leafy thallus. Apothecia in *L. spadicea* have mostly swollen edges, low to moderately arched and larger brown discs while those in *L. aipospila* are smaller and lightly to strongly arched with red-brown.

Opegrapha subelevata Nyl.

Specimen examined: İstanbul: Heybeliada, 40°52’46”N, 29 °05’29”E, on a pebbled concrete garden wall, 17 m, 20 August 2007. Yazici 1555. (accompanying species: *Diploicia canescens* and *Caloplaca flavescens*).

Thallus thin to somewhat thick or ± immersed, smooth to finely cracked and granular, ash- to yellow-grey. Apothecia 0.5–1.5(–2.5) × 0.12–0.3(–0.4) mm, scattered to crowded, elongate, ± sessile, elevated, occasionally furcate, ends often acute; disc usually exposed, densely mauve-grey pruinose; exciple thin, non-pruinose, K–.

Epithecium brown; hymenium 80–90µm tall. Subhymenium colourless 30–50 µm; mature ascus 55–75 × 14–18 µm, young ascus 40–50 ×12–13 µm. Ascospores 20–25 × 6–7µm, 3-septate, ± elongate-clavate, ellipsoid–fusiform, sometimes becoming brownish when old. Conidia 4–5 × 0.8–1 µm, bacilliform or slightly curved. Thallus P–, K–, KC–, C– UV–.

A mild-temperate lichen, found on calcareous or basic siliceous rocks, sometimes on mortar walls, mostly near the coast. On steep limestone rocks, mortar or ± basic sandstone or slate rocks, very rare.

Collection site – The predominately mild climate has cold, hot, and two transitional seasons, with temperatures never below freezing and northern winds dominating. The

gently sloped terrain is sunny and covered with pine forests intermixed with numerous house gardens.

Known distribution: Europe (Channel Is, England,; Germany, France, Italy, Spain, Portugal, Greece — Crete, Kalimnos, Kerkira, Kos), Algeria, Egypt, Israel, Syria, Thailand. New to Turkey.

Remarks—The prominent apothecia with open grey-blue pruinose discs and black, naked margins are distinctive. *Opegrapha subelevata* is distinguished from *O. ochrocheila* by its larger apothecia, shorter conidia, and larger ascospores.

Physconia isidiigera (Zahlbr.) Essl.

Specimen examined: Uşak: Karahallı, Paşalar village, 38°20'32"N, 29°29'17"E, on bark of *Quercus* sp., 960 m, 20 August 2007, Yazici 1556.

Thallus 3–4 cm in diam., heavily pruinose, whitish to greyish to brownish, with conspicuously squarrose black rhizines and usually with dissected lobes; characterized by more or less elongate, linear, marginal and sometimes recurved but not lip-shaped soralia, which are sometimes weakly reflexed in part, but not at all labriform; soredia coarse along margins, becoming confluent in centre of old thalli, especially in dry situations, finely granular to distinctly corticate in most cases and thus strongly resembling isidia in some forms; medulla white; upper cortex paraplectenchymatous; lower surface pale brown to black, at least in the centre of the thallus. Soralia K–, KC–. Medulla K–, KC–.

Abundant in the mountains on bark, wood and rock, on barks of *Quercus* sp., and also on base of *Magnolia* sp.

Collection site – The climate is mediterranean with hot dry summers and cold snowy winters, a mean annual rainfall of 557 mm and a mean annual temperature of 12.5 °C, with maximum and minimum means of 23.6°C (July) and 2.4°C (January) respectively. The site is well lit and lies among agricultural areas and extensive plains.

Known distribution: Canada (Alberta), U.S.A. (California), England. New to Turkey and Asia.

Remarks – The thallus of *Physconia isidiigera* closely resembles *P. detersa*, which is differentiated by thinner walled cortical cells; *P. isidiigera* specimens with ecorticate, granular (non-isidioid) soredia have been often mistaken for *P. detersa,* but the upper cortex in *P. detersa* is scleroplectenchymatous, not distinctly paraplectenchymatous as in *P. isidiigera.*

Physconia enteroxantha is also similar but is distinguished by a pale yellow to almost white medulla and different chemistry (KC+ yellow-orange, sometimes slight but always detectable and K+ yellow-orange).

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Taxonomic and phylogenetic revision of *Coniophora arachnoidea, C. opuntiae,* and *C. prasinoides*

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Abstract — The authors revised type material from three *Coniophora* species (*C. arachnoidea, C. opuntiae* and *C. prasinoides*), applying morphological techniques. A phylogenetic analysis of ITS sequences was conducted for several related *Coniophora* species. *C. opuntiae* is proposed to represent a synonym of *C. arachnoidea*, whereas *C. prasinoides* is maintained as an independent taxon. Microphotographs of the most representative characters of the specimens are presented.

Key words — *Basidiomycota*, *Boletales*, taxonomy, molecular phylogeny, France, Guinea, Spain

Introduction

The genus *Coniophora* DC. (*Coniophoraceae, Boletales*) was erected by De Candolle (1815) for *Coniophora membranacea* DC., which at present is considered a synonym of *Coniophora puteana* (Schumach.) P. Karst., this epithet having priority. Members of this genus develop their basidiomata mainly on wood (conifers and deciduous trees), causing brown rot and seriously damaging the affected wood. Likewise, other members of *Corticiaceae* sensu lato such as *Phlebia* Fr. (= *Merulius* Fr.) and *Serpula* (Pers.) Gray, also produce important economical losses in the building sector. Fungi attacking wood in buildings are excellently presented in the work by Huckfeldt & Schmidt (2006), with colour photographs and identification keys to genus or even species level.

Amongst the taxonomic works on *Coniophora* the monograph by Ginns (1982) represents a hallmark, together with the classical work by Bourdot & Galzin

(1928). Ginns (1982) considered *Coniophora* within the family *Coniophoraceae* and separated it from closely related genera on the basis of a combination of characters, including "hyphae with simple septa and typically with scattered single, double or verticillated clamps." He recognized the following genera in the family: *Gyrodontium* Pat., *Serpula*, *Leucogyrophana* Pouzar, *Jaapia* Bres., and *Corneromyces* Ginns. The different species of *Coniophora* were separated in a dichotomous key based on classical macro- and microscopical characters such as spore size and shape, dextrinoid reaction of basidiospores, presence or absence of cystidia, whether the hyphal system is monomitic, dimitic or trimitic, basidioma morphology, and substrate adherence. In addition, he provided data from plate cultures for 6 out of the 15 species discussed. In his work on species of the *Coniophoraceae* from northern Europe, Hallenberg (1985) recognized three genera within the family (*Coniophora*, *Serpula* and *Leucogyrophana*) and described only four *Coniophora* species. The genera *Serpula* and *Meruliporia* Murrill were treated in an extensive work by Cooke (1957), who also included *Jaapia*, *Coniophora*, *Coniophorella* P. Karst. (at present considered a synonym of *Coniophora*), and *Gyrodontium*.

Molecular analyses confirm the position of *Coniophora* and related genera within *Boletales* (Binder & Hibbett 2006, Larsson et al. 2004). According to Hibbett & Thorn (2001) the corticioid fruitbody shape derived from pileate and erect ones.

In this work we compare three critical *Coniophora* species that can be easily confused: *C. arachnoidea*, *C. prasinoides,* and *C. opuntiae*, all characterized by a monomitic hyphal system with simple-septate hyphae and by comparatively smaller spore sizes.

Materials and methods

Material examined

The material studied is preserved in the following dried reference collections: AH (Universidad de Alcalá de Henares), BPI (The National Fungus Collections, U.S.A.), DAOM (National Mycological Herbarium, Canada), FH (Farlow Herbarium, U.S.A.) and MA-Fungi (Real Jardín Botánico Madrid).

Descriptions of the macro- and micromorphological characteristics were based on herbarium material except for the sample AH 31855, which was studied fresh after collecting. The micromorphological characters were also studied from dried reference material, using KOH 5%, ammonia Congo red, Melzer's reagent and distilled water. Cotton blue was used to study the spore germination pore and cyanophilic elements.

DNA extraction, PCR amplification, and DNA sequencing

DNA was extracted from small basidiomata fragments of *C. opuntiae* AH 31855 following previously described methods (Peláez et al 1996). The ITS1-5.8S-ITS2 fragment was amplified using the ITS1F and ITS4b primers (Gardes & Bruns 1993).

PCR amplifications followed standard procedures (5 min at 93°C, then 40 cycles of 30 s at 93°C, 30 s at 53°C and 2 min at 72°C) using Taq DNA polymerase (QBiogene, Inc.) following the procedures recommended by the manufacturer. Amplification products (0.1 µg/ml) were sequenced using the Big Dye Terminator Cycle Sequencing Kit (Applied Biosystems) following manufacturer recommendations. Each strand of the amplification products was sequenced with the same primers used for the initial amplification. Partial sequences obtained during sequencing reactions were assembled using BioEdit 7.0.5.3 (Hall 1999). The DNA sequence was compared with GenBank database using BLAST application. Alignment of the best matching sequences was also performed using BioEdit 7.0.5.3. Finally, the alignments were visually adjusted with GeneDoc 2.5 software (Nicholas & Deerfield 1997). Genbank FJ790314.

Phylogenetic analysis

Bayesian analysis based on Markov chain Monte Carlo (MCMC) approach was run using MrBayes 3.01 (Ronquist & Huelsenbeck 2003). To improve mixing of the chain, four incrementally heated simultaneous Monte Carlo Markov chains were run over 2,000,000 generations. MrModeltest 2.2 (Nylander 2004) was used to perform hierarchical likelihood ratio tests to calculate the Akaike information criterion (AIC) values of the nucleotide substitution models. The model selected by AIC for the alignment of the ITS1-5.8S-ITS2 gene fragment was the GTR+G model allowing six classes of substitution types, a portion of invariant alignment positions, and mean substitution rates varying across the remaining positions according to a gamma distribution. Priors used for the MCMC process were a Dirichlet distribution for substitution rates and nucleotide frequencies and a uniform prior for the rate parameter of the gamma distribution. Both types of analysis used the sampling frequency of 100 to store trees, with the 1000 first trees discarded to obtain a majority rule consensus tree.

Taxonomy

Coniophora arachnoidea Pat., Bull. Soc. Mycol. France 28: 31 (1912). Figs. 1–3

Specimens examined—GUINEA. Camayenne–feuilles de Bananier–29.VI.1910–leg. M. Duport 65, herb. Patouillard *3376* in *FH 258812* Holotype.

Type information — The type material is conserved in a paper envelope containing a white cardboard with four banana leaf fragments, two ~3 × 3 cm squares with scarce fruiting bodies, one rectangle (5.5 × 1 cm) without any fruitbodies, and one very small piece (2 × 0.5 cm) with sparse fruiting bodies. In addition there are two labels, one small hand written label with the collection data and the number 65, and a review label from J.H. Ginns. Only the type material of this species is known.

Description — Basidioma attached to the substrate, although easily detachable in some areas. Hymenophore membranaceous, brownish or straw-coloured with olivaceous tones. Margin fibrous and whitish. Hyphal system monomitic, without clamp connections. Context consisting of cylindrical hyphae, septate, cyanophilic, 2.5–6 µm wide, without incrustations. Tetrasporic basidia, 40–43

× 6–7 µm. Spores 6–8 × 4–5 µm, ellipsoid, brownish, thick walled, cyanophilic, non-dextrinoid or only slightly dextrinoid sometimes, with a paler apical zone corresponding to a rudimentary germ pore, sometimes difficult to observe.

Coniophora opuntiae Tellería, An. Jard. Bot. Madrid 41(1): 26 (1984).

Figs. 4–6, 11–15

Specimens examined—SPAIN. Almería: San José, road fromSan José to Cabo de Gata, near Morrón de los Genoveses–1.XII.1983–on *Opuntia* sp., leg. F.D.Calonge, M.Dueñas & M.T.Tellería, 4460Tell. in *MA-Fungi 6900 Holotypus.* Almería: Turrillas on cladodia of *Opuntia ficus-indica,*–8-II-2008–leg. G.Moreno & J.Checa, *AH 31855.*

type information — The type material is conserved in a paper envelope and inside there is another envelope with a white cardboard. The sample is very abundant, containing six fragments of *Opuntia* cladodia with many fruiting bodies. In addition, a small paper envelope with small sample fragments is also conserved. A detailed description by the author with pencil drawing of spores, basidia, and hyphae is also included.

description — Basidioma resupinate, membranaceous, easily detachable from the substrate. Hymenium smooth, olivaceous, margin pale, whitish to yellowish, with whitish mycelial cords. Hyphal system monomitic, without clamp connections. Context consisting of cylindrical hyphae, septate, cyanophilic, 3–5 µm wide. Tetrasporic basidia, 30–50 × 6–8 µm, clavate. Spores 6–8 × 4–5 µm, ovoid to broadly ellipsoid, yellowish to yellow-brownish, thick walled, cyanophilic, non-dextrinoid or occasionally only very slightly dextrinoid, with a paler apical zone corresponding to a rudimentary germ pore, sometimes difficult to observe.

The sample AH 31855, collected in the same province (Almería) and on the same substrate (*Opuntia ficus-indica*), showed somewhat larger basidia (40–60 × 5–6.5 µm) and spores (7.5–10 × 4–6 µm). These differences are attributed to intraspecific variability.

Coniophora prasinoides (Bourdot & Galzin) Bourdot & Galzin,
Hyménomyc. de France (Sceaux): 361 (1928). Figs. 7–10

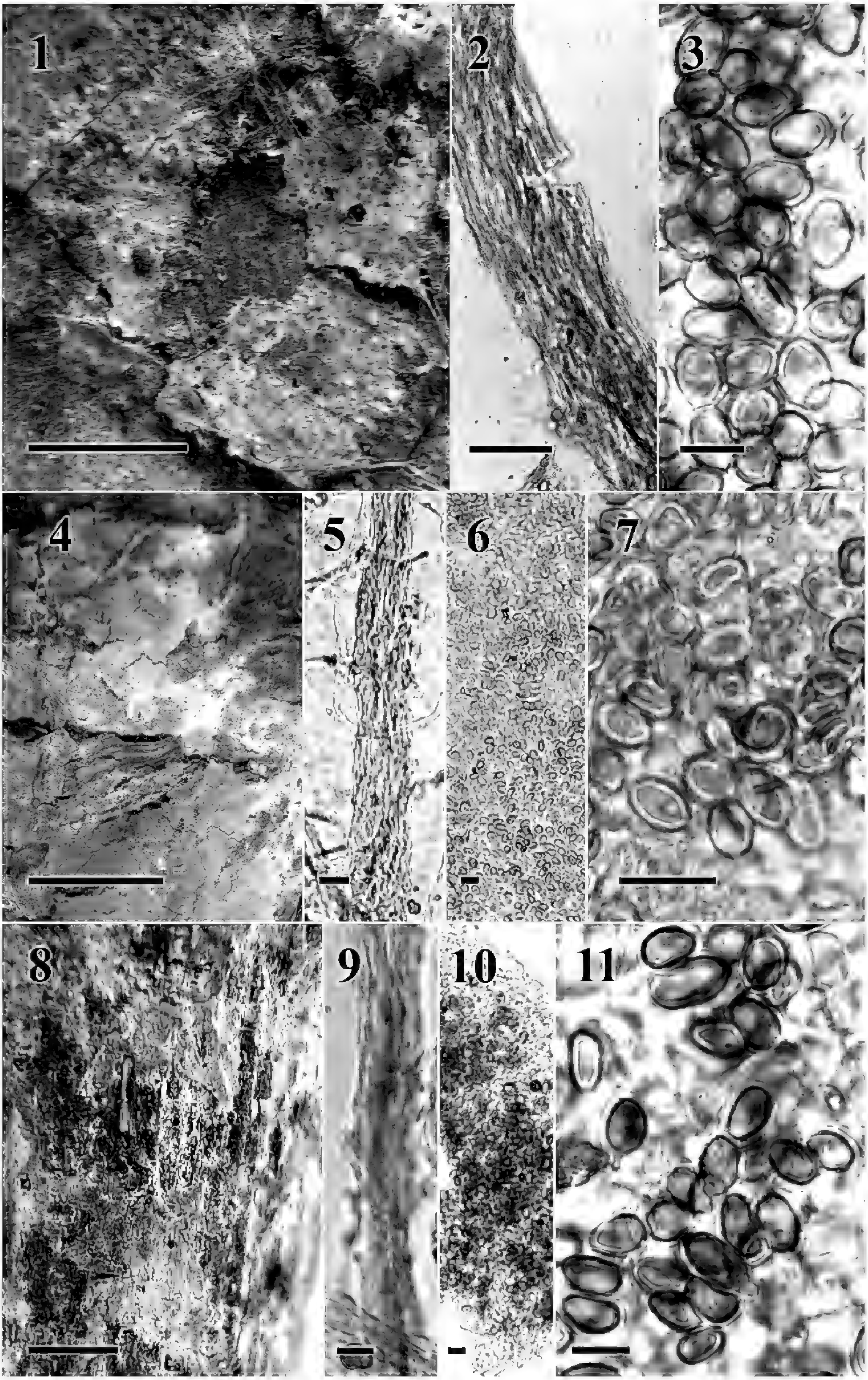
≡ *Coniophora olivacea* subsp. *prasinoides* Bourdot & Galzin, Bull. Soc. Mycol. France 39: 115 (1923)

Figs. 1–3 *Coniophora arachnoidea* type: 1. Basidioma. 2. Cyanophilic mycelial cord in cotton blue. 3. Non-dextrinoid spores in Melzer´s reagent.

Figs. 4–7 *Coniophora opuntiae* type: 4. Basidioma. 5. Cyanophilic mycelial cord in cotton blue. 6–7. Non-dextrinoid spores in Melzer´s reagent.

Figs. 8–11 *Coniophora prasinoides* type: 8. Basidioma. 9. Cyanophilic mycelial cord in cotton blue. 10–11. Dextrinoid spores in Melzer´s reagent.

Scales: 1 = 0.5 cm, 2 = 20 µm, 3 = 10 µm, 4 = 1 cm, 5–7 = 10 µm, 8 = 0.25 cm, 9–11 = 10 µm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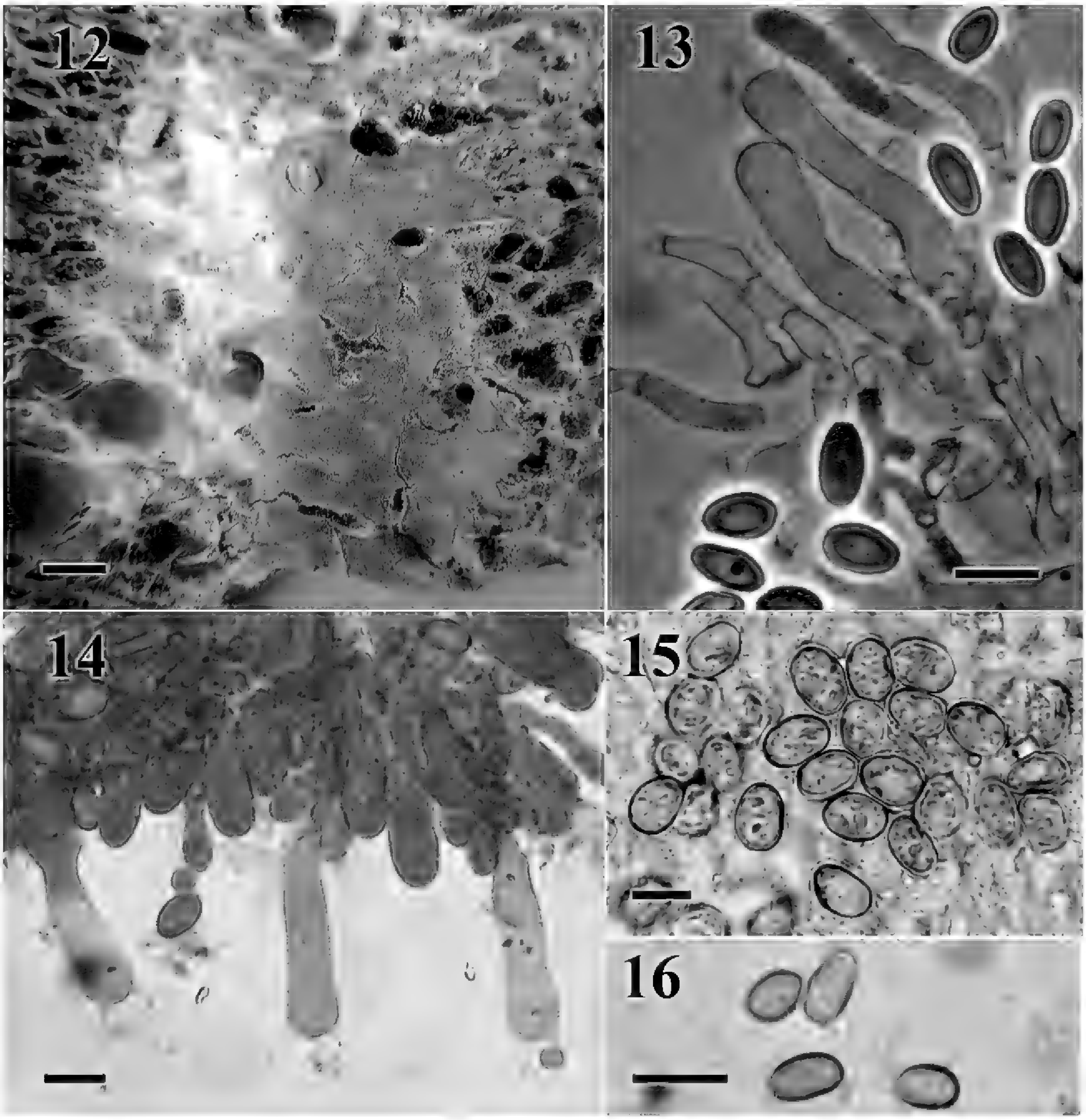

Figs. 12–16 *Coniophora opuntiae* AH 31855: 12. Basidioma. 13. Hymenophore in phase contrast. 14. Hymenophore in ammonia Congo red. 15. Spores in KOH 5%. 16. Spores in Melzer's reagent Scales: 12 = 0.5 cm, 13–16 = 10 µm

Specimens examined—FRANCE. L'Aveyron, ad rames *Vitis viniferae*, –XI.1916–leg. Galzin 20845, Herb. H. Bourdot 18607, ex Herb. Bresadola in *BPI USO290325* isolectotype. UNITED STATES. Maryland: College Park, old southern pine flooring stored in open 9 months–16.XI.1965–leg. H.H. McKay, det. J.H. Ginns, FP 105969-sp, ex BFDL in *DAOM 137642* (*AJ 419197*).

Type information — The type material is conserved in a paper envelope fixed to a herbarium sheet. Inside this there is a plastic bag containing the sample, consisting of highly fragmented wood pieces with fruitbodies only on three large fragments, and only in one case is the specimen acceptably preserved. In addition, there are two review labels, one from J.H. Ginns and the second from

Anton R. Slysh. In the paper envelope there is also a microscopic description with ink drawings of the spores and hymenium, with the collection data numbered as 18607 Herb. H. Bourdot, and at the left edge a stamp with the legend "Abate G. Bresadola Trento." Therefore, this sample belonging to Bresadola's herbarium and conserved today at BPI, must be considered an isolectotype of *Coniophora prasinoides*. The lectotype was created by Ginns (1982) for collection 18608 deposited in PC.

Description — Basidioma attached to the substrate, easily detachable in some areas. Hymenium smooth, membranacous, brownish or straw-coloured with greenish to yellowish tones. Margin fibrous and whitish. Hyphal system monomitic, without clamp connections. Context consisting of cylindrical hyphae, septate, cyanophilic, 4–6 µm wide, without incrustations. Tetrasporic basidia, 40–55 × 6–8 µm, clavate. Spores 7–11 × 5–7 µm, ellipsoid, yellowish to yellow-brownish, thick walled, cyanophilic, strongly dextrinoid, with a paler apical zone corresponding to a rudimentary germ pore, sometimes difficult to observe.

Another sample growing on pine wood (DAOM 137642, a duplicate of which is conserved in MA-Fungi 19417) was also examined, showing the same characteristics as the type material, both macro- and microscopically.

Results and discussion

Coniophora opuntiae was separated by Tellería (1984) from the two species sharing small spore sizes, *C. arachnoidea* and *C. prasinoides*, based on the characters related to hyphae, spores and habitat, as indicated in Table 1 (based on the cited author's data).

According to Table 1, *C. arachnoidea* would differ from *C. opuntiae* by spores having an apical germination pore and rarely showing a dextrinoid reaction, as well as in their different habitats. The type material of *C. arachnoidea*, the only material of the species available for study, was not directly examined by Tellería (1984), who based the characters reported on the Ginns 1982 description. Thus, the reaction of the hyphal walls to lactophenol blue was unknown, as indicated in Table 1. *Coniophora prasinoides* was said to differ from *C. opuntiae* by rarely forming hyphal cords, non-cyanophilic hyphal walls, broader spores [4.3–6.9 (–7.5) µm] with germ pore, and different habitat. For *C. prasinoides,* Tellería studied DAOM 137642, which corresponds to American material determined by Ginns.

However, when the type materials of these three species are studied in detail, the diagnostic characters (presence of mycelial cords, germ pore, dextrinoid spores) are often difficult to appreciate, and they sometimes vary depending on the microscopic preparation. We summarize our observations as follows:

Coniophora arachnoidea shows mycelial cords with cyanophilic hyphal cell walls, spores 6–8 × 4–5 µm, generally non-dextrinoid, only some spores are very slightly dextrinoid, showing a rudimentary germ pore.

Coniophora prasinoides also shows mycelial cords with cyanophilic hyphal cell walls, larger spores (7–11 × 5–7 µm), cyanophilic, strongly dextrinoid and with a rudimentary germ pore.

Coniophora opuntiae shows mycelial cords with cyanophilic hyphal cell walls, spores 6–8 × 4–5 µm, cyanophilic, mostly non-dextrinoid, only some spores slightly dextrinoid, and showing also a rudimentary germ pore.

There are two points where our observations do not concur with the original description of *C. opuntiae* by Tellería (1984). First, the spores were indicated to be dextrinoid while we did not find dextrinoidity or at most only rarely and very slightly. In general, the spores appeared non-dextrinoid. Likewise, the germ pore was said to be nonexistent, but we observed the same rudimentary germ pore, although often difficult to observe, as seen in the other two species studied here. In addition, we noted cyanophilic hyphal cell walls in *C. prasinoides* (see Table 1).

Table 1. Comparison of *Coniophora arachnoidea*, *C. prasinoides*, and *C. opuntiae*. *

	C. arachnoidea	*C. prasinoides*	*C. opuntiae*
Mycelial cord	Present, with broader (10–16 µm) hypha in mid-region	Rarely formed; when present consisting of 3–5 µm broad hyphae and one slightly broader central hypha	Present, with broader (13 µm) hypha in mid-region
Hyphal cell wall	? **(cyanophilic)**	Not cyanophilic **(cyanophilic)**	Cyanophilic **(cyanophilic)**
Spores:			
Shape	Broadly ellipsoid, sometimes narrowly to broadly ellipsoid	Ovoid, broadly ovoid, or broadly ellipsoid	Ellipsoid, broadly ellipsoid. or ovoid
Germ pore	Present	Present	Absent **(rudimentary germ pore)**
Reactions	Cyanophilic, rarely dextrinoid **(not to rarely slightly dextrinoid)**	Cyanophilic, dextrinoid **(strongly dextrinoid)**	Cyanophilic, dextrinoid **(not to rarely slightly dextrinoid)**
Size	6.7–9(–9.6) × 3.8–5.5 µm	7.4–10 × 4.3–6.9(–7.5) µm	6–8 × 4–5 µm
Habitat	Banana leaves	Wood of *Pinus*, *Vitis vinifera*, and *Salix*	Cladodia of *Opuntia*

*Based on Tellería (1984); new observations added in **bold** font and parentheses.

The examination of additional specimens adds even more complexity to the characterization of the differences between these species. Thus, a new collection of *C. opuntiae* from the same habitat and location as the type material (AH 31855) showed a slightly different spore size range (7.5–10 × 4–6 µ) that places this specimen closer to *C. prasinoides* regarding only spore size.

In summary, we distinguish two *Coniophora* groups: on the one hand *C. prasinoides*, characterized by strongly dextrinoid and slightly larger spores, and on the other, *C. arachnoidea* and *C. opuntiae*, with non-dextrinoid and somewhat smaller spores. We have not detected any meaningful morphological differences between the latter two species. Although their reported habitat is different [banana leaves (*Musa* sp., *Musaceae*) for *C. arachnoidea* and cladodia of *Opuntia ficus-indica* (*Cactaceae*) for *C. opuntiae*], it could be claimed that they are somewhat related substrates, since both types of structures accumulate water in their tissues.

We could not carry out molecular studies of the type material of *C. arachnoidea* and *C. prasinoides*; because they are very old and scarce material and successful DNA extraction seemed questionable, we decided not to put valuable type material at a risk. We have sequenced new material of *C. opuntiae* from the same location as the type material (AH 31855). On the other hand, Martín & Raidl (2002) had previously obtained the ITS sequence of *C. prasinoides* DAOM 137642 (a specimen which we have studied also morphologically), allowing at least the comparison of these two species by molecular methods.

The ITS region of *C. opuntiae* was successfully amplified. The size of the whole region was 640 bp. BLAST analysis revealed that its closest match was *Coniophora olivacea* (Fr.) P. Karst., with a 91–92% homology in the ITS1-5.8S-ITS2 region. The homology with *C. prasinoides* was 86% in the same region. These data support *C. opuntiae* and *C. prasinoides* as two different species.

The phylogenetic analysis based on the alignment of ITS sequences from a group of *Coniophora* species is shown in Figure 17. The size of the alignment was 729 nucleotides, while 520 of these characters were constant. Bayesian analysis showed that *C. opuntiae* clustered with sequences of *C. olivacea* with a moderate clade support value (posterior probability value 0.89). *Coniophora olivacea* differs from *C. opuntiae* by the presence of septate, long, brown cystidia, lacking in *C. opuntiae*. Both species were included together with *C. prasinoides* and *Coniophora marmorata* Desm. in one larger clade with strong clade support (0.93). These four species therefore seem to be more closely related, compared with other *Coniophora* species such as *Coniophora arida* (Fr.) P. Karst. and *C. puteana*. *Coniophora marmorata* shares the small spore size (7–9.8 × 4.5–7 (–8) µm) with *C. opuntiae* and is mainly distinguished by its dimitic hyphal system. In addition, the segregation of *Coniophorella* from *Coniophora* seems to be artificial and is not supported by the present molecular analysis.

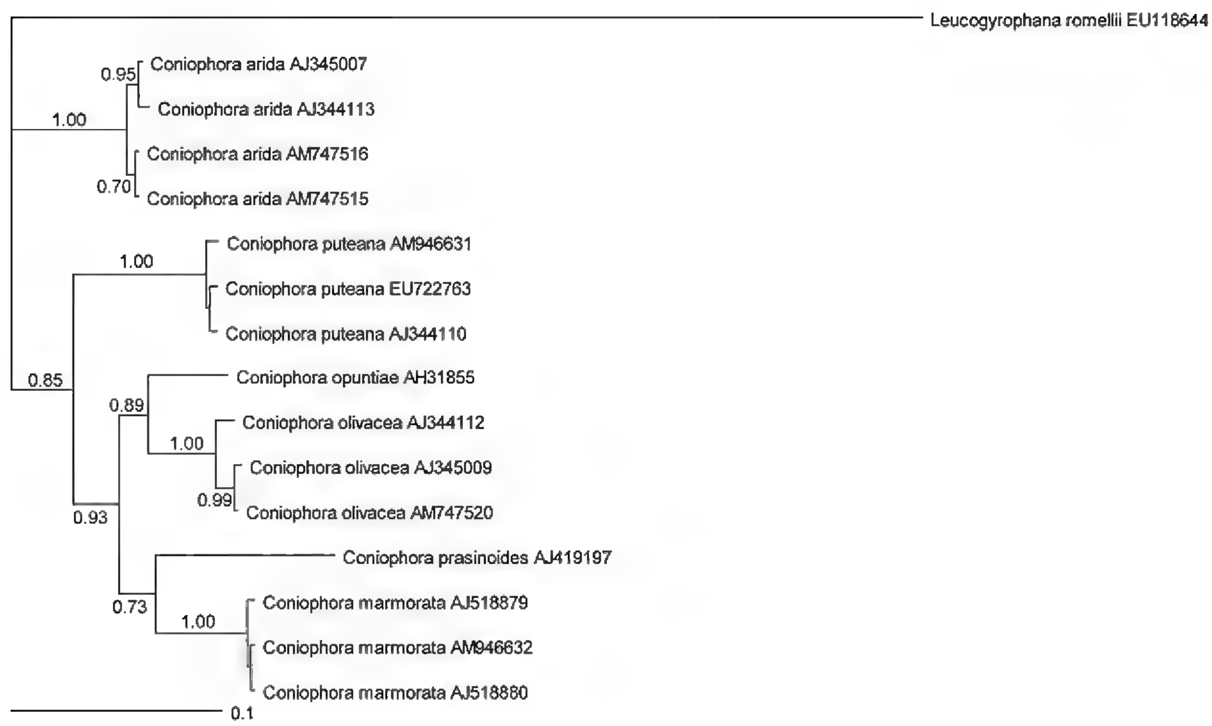

Fig. 17. Phylogenetic analysis based on the alignment of ITS sequences from a group of *Coniophora* species. Clade credibility values are given on the branches. Note the significative phylogenetic distance regarding *C. prasinoides* and *C. opuntiae*.

Conclusions

Based on the morphological and molecular data presented above, we conclude that *Coniophora prasinoides* and *Coniophora opuntiae* represent two different species. We consider *Coniophora arachnoidea* and *C. opuntiae,* which cannot be distinguished morphologically, as synonyms, with the older epithet, *C. arachnoidea,* having priority.

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Two new species and a new Chinese record of *Exobasidium* (*Exobasidiales*)

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Abstract —Two new species, *Exobasidium yunnanense* on *Camellia sinensis* and *E. deqenense* on *Rhododendron* sp., are reported. They were collected from Yunnan Province. *Exobasidium canadense* on *Rhododendron* sp. and *Rhododendron mariesii* is a new Chinese record, from Jiangxi Province.

Key words —*Exobasidiomycetes*, symptoms, taxonomy

A new species of *Exobasidium* on *Camellia sinensis* was collected from Yunnan Province in 2005. The host plant belongs to the subfamily *Theoideae* of *Theaceae*. The *Exobasidium* species is parasitic on young leaves causing leaf spots. The upper side of the diseased leaves is slightly concave, and pale green; when mature the under side is covered with white hymenium. Usually there are several spots on each leaf. Transverse sections of a diseased leaf clearly show the differentiation of the palisade and mesophyll cells. There is slight hypertrophy of plant cells. The new species of *Exobasidium* is characterized by the number of sterigmata 2(–3) and the large basidiospores measuring 10–23(–25) × 4–6 µm. The leaf spot is similar to that caused by *Exobasidium vexans* Massee (Sawada 1919) on *Camellia sinensis*. However, *E. vexans* has smaller basidiospores, measuring 11–16 × 3.5–6 µm. The new species is described as:

Exobasidium yunnanense ZhenYing Li & L. Guo, **sp. nov.** Figs. 1,4–6

MycoBank MB510677

Hymenium hypophyllum. Basidia hyalina, clavata vel cylindrica, 5–9 µm lata, terminaliter 2(–3) sterigmatibus 3–5.5 × 1–2 µm praedita. Basidiosporae ellipsoideae vel cylindricae,

*corresponding author

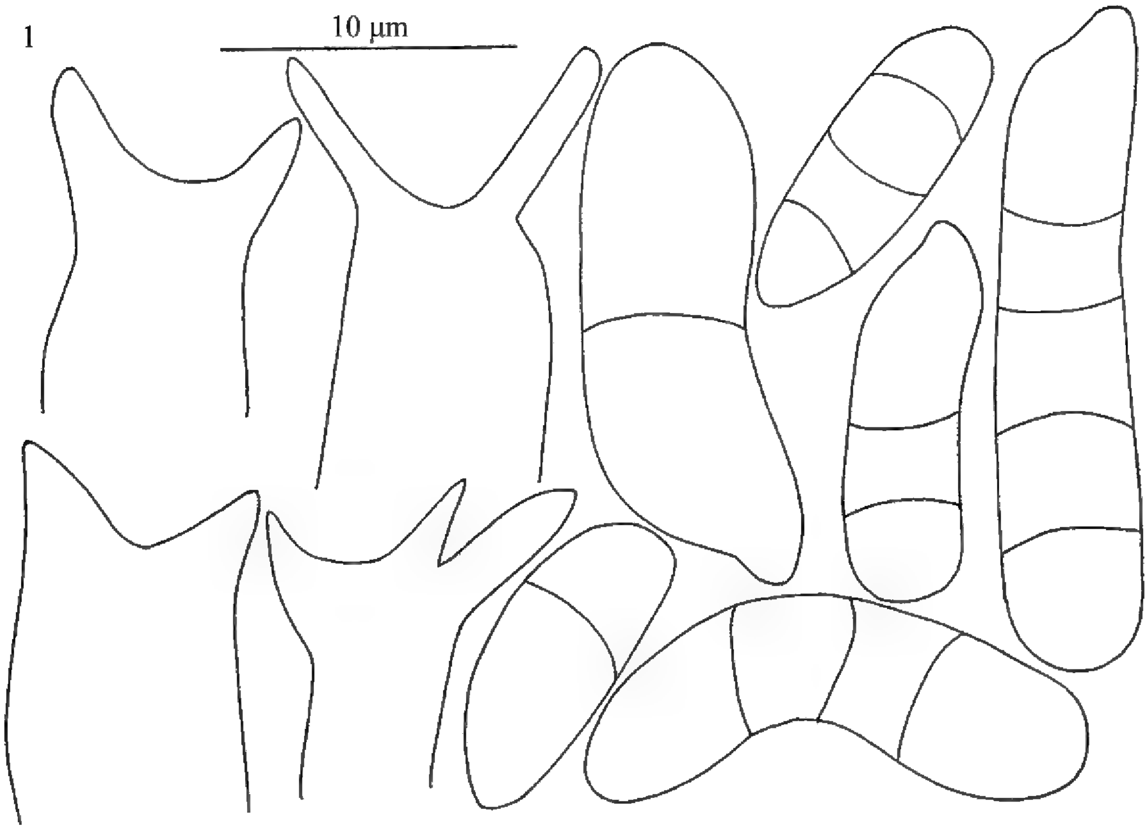


FIG. 1. Basidia, sterigmata, and basidiospores of *Exobasidium yunnanense* on *Camellia sinensis* (HMAS 167369, holotype).

interdum curvae, 10–23(–25) × 4–6 µm, hyalinae, laeves, primo continuae, dein 1–4(–5)-septatae.

Hymenium hypophyllous. Basidia hyaline, clavate or cylindrical, 5–9 µm wide, with 2(–3) sterigmata. Sterigmata conical, 3–5.5 × 1–2 µm. Basidiospores ellipsoidal or cylindrical, occasionally curved, 10–23(–25) × 4–6 µm, hyaline, smooth, at first continuous, then 1–4(–5)-septate.

SPECIMEN EXAMINED—On *Camellia sinensis* (L.) Kuntze (*Theaceae*), Yunnan: Tengchong, alt. 2180 m, 19 IX 2005, Z.Y. Li, L. Guo & N. Liu 218, HMAS 167369 (holotype).

The second new species of *Exobasidium* was collected from Deqen, Yunnan Province, in 2000 by Prof. Zhuliang Yang. The new species is parasitic on young leaves of *Rhododendron* sp., causing leaf hypertrophy and deformation. The infected parts of the leaves are concave on the upper surface and convex on the lower surface. The diseased parts are subglobose to hemi-globose, 1–4 × 0.5–3 cm in size, usually one on each leaf. The color is yellowish brown when dry. This new species is characterized by the wide basidia (measuring 7.5–9 µm in width), the number and size of sterigmata [2(–3), measuring (4–)5–7.5 × 3–4.2 µm] and the wide basidiospores [(5–)6.5–8 µm in width]. Two other species of *Exobasidium* causing leaf spots on *Rhododendron* show similarities. The new species differs from *Exobasidium shiraianum* Henn. (Nagao et al. 2004), which has smaller sterigmata measuring 2–5 × 1–1.5 µm and differs from *E. taihokuense* Sawada (Sawada 1959), which has narrower basidia and

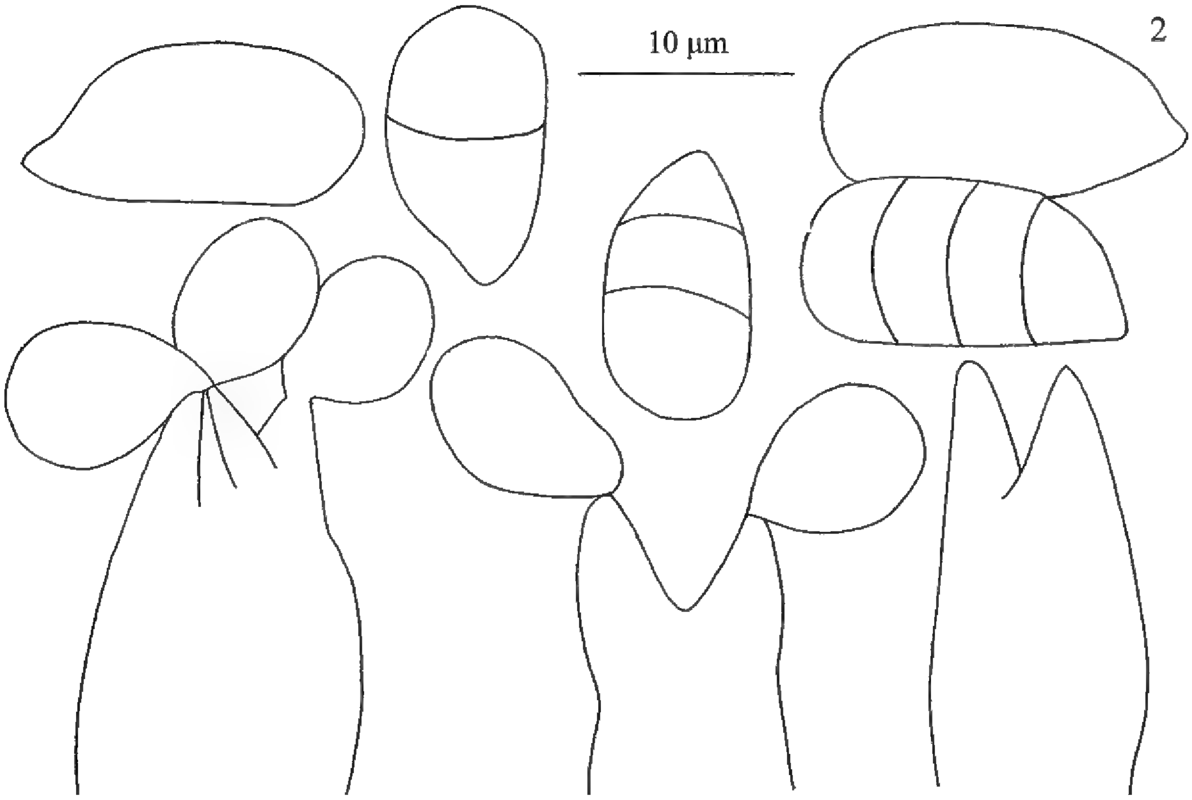


FIG. 2. Basidia, sterigmata, and basidiospores of *Exobasidium deqenense* on *Rhododendron* sp. (HKAS 36550, holotype).

basidiospores measuring 5–7 μm in width and 3.5–5 μm in width, respectively. The new species is described as:

Exobasidium deqenense ZhenYing Li & L. Guo, **sp. nov.** FIGS. 2, 7–9
MYCOBANK MB510821

Hymenium amphigenum. Basidia hyalina, cylindrica, 7.5–9 μm lata, terminaliter 2(–3) sterigmatibus (4–)5–7.5 × 3–4.2 μm praedita. Basidiosporae cylindricae vel subclavatae, (8–)13–16(–17) × (5–)6.5–8 μm, hyalinae, laeves, primo continuae, dein 1–3-septatae.

Hymenium amphigenous. Basidia hyaline, cylindrical, 7.5–9 μm wide with 2(–3) sterigmata. Sterigmata conical, (4–)5–7.5 × 3–4.2 μm. Basidiospores cylindrical or subclavate, (8–)13–16(–17) × (5–)6.5–8 μm, hyaline, smooth, at first continuous, then 1–3-septate.

SPECIMEN EXAMINED—on *Rhododendron* sp. (*Ericaceae*), Yunnan: Deqen, Meilixueshan, alt. 4350 m, 30 VIII 2000, Z.L. Yang 3037, HKAS 36550 (holotype).

Exobasidium canadense, discovered in Jiangxi Province, is a new Chinese record. It is parasitic on *Rhododendron* sp. causing leaf spots, usually 1–3 on each leaf. The upper side of the diseased parts is slightly concave, pale yellow and when mature the under side is covered with white hymenium. The leaf spots can be up to 4.5 mm in diam. Transverse sections of the diseased leaf show the differentiation of the palisade and mesophyll cells clearly. There is no hypertrophy of plant cells.

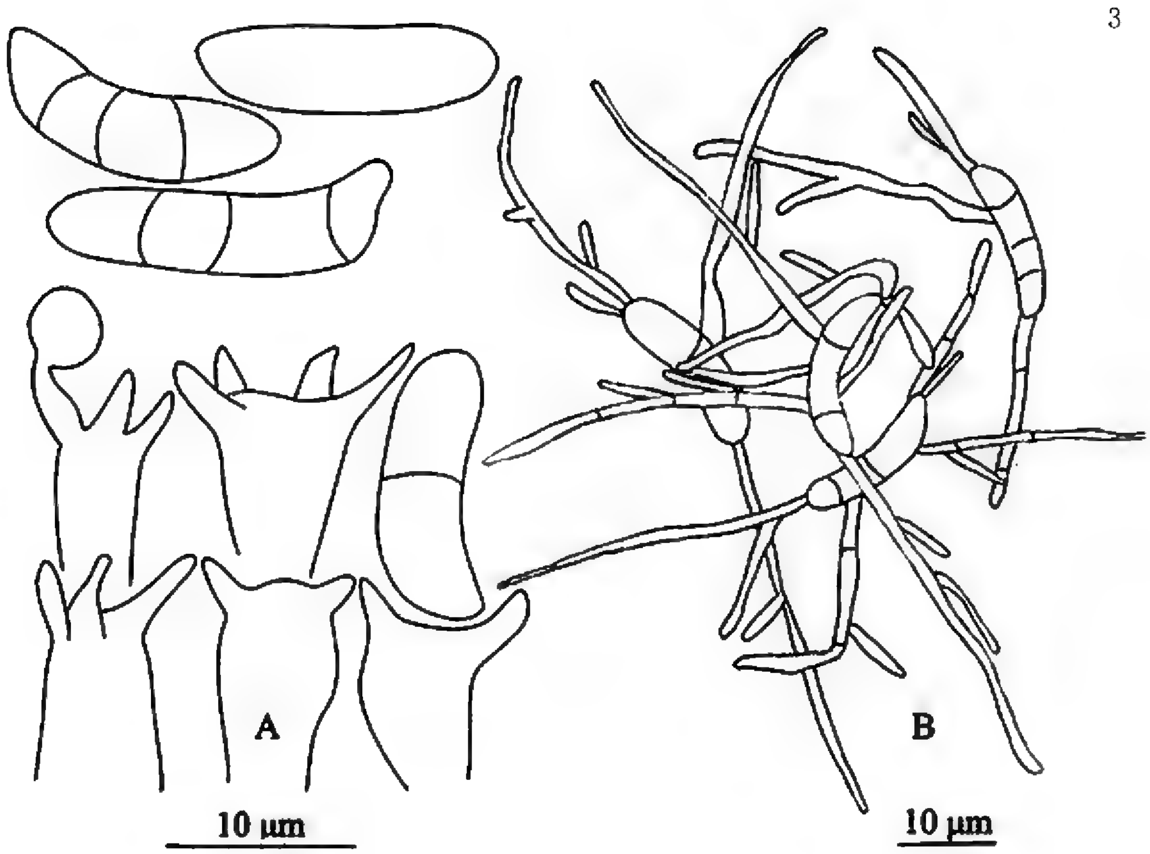


Fig. 3. Basidia, sterigmata and basidiospores of *Exobasidium canadense* on *Rhododendron* sp. (HMAS 167371). A. Basidia, sterigmata and basidiospores. B. Basidiospore germination.

Exobasidium canadense Savile, Can. J. Bot. 37: 651, 1959. **Figs. 3, 10–13**

Hymenium hypophyllous, white. Basidia hyaline, clavate or cylindrical, 7–40 × 4–8 µm, with 2–4 sterigmata. Sterigmata conical, 3.5–5.5 × 1.2–2.3 µm. Basidiospores ellipsoidal, often curved, 14–20 × 4–5 µm, hyaline, smooth, at first continuous, then 1–3(–4)-septate.

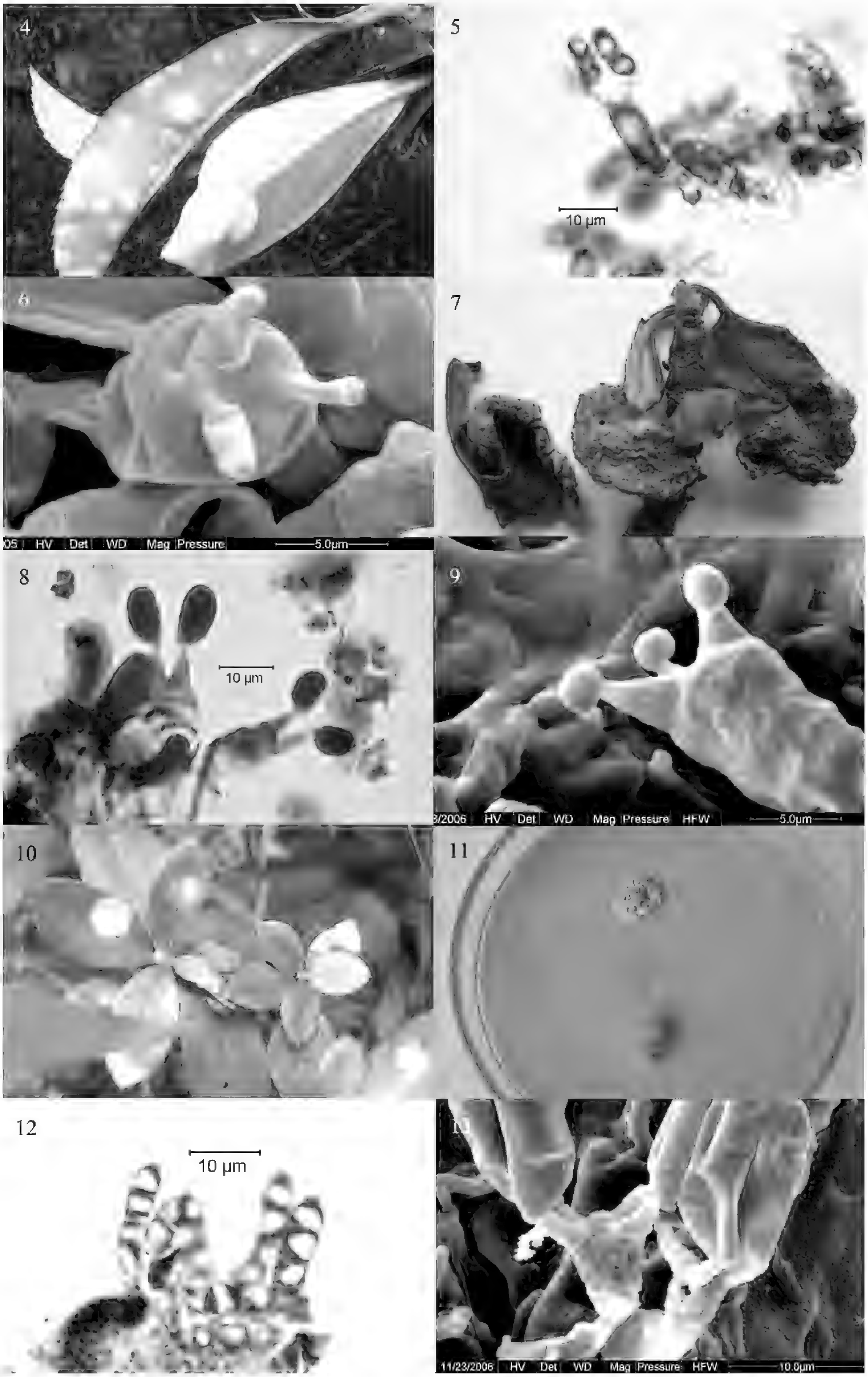
Specimens examined—On *Rhododendron* sp. (*Ericaceae*), Jiangxi: Jinggangshan, Shangjing, alt. 982 m, 22 IX 2006, Z.Y. Li, C.X. Lu & L. Guo 374, HMAS 167371. On *Rhododendron mariesii* Hemsl. & E.H.Wilson (*Ericaceae*), Jiangxi: Lushan Botanical Garden, 14 V 2007, Z.Y. Li & L. Guo 633, HMAS 173409.

Colonies on potato dextrose agar (PDA) grew slowly, to a maximum 12 mm diameter after 21 days incubation at 25°C. The colony was yellow and corrugate on the surface, composed of conidia. Conidia bacilliform, 5–9 × 1–1.2 µm.

Figs. 4–6. *Exobasidium yunnanense* on *Camellia sinensis* (HMAS 167369, holotype). 4. Symptoms. 5. Basidia, sterigmata and basidiospores as seen by LM. 6. Basidium and sterigmata as seen by SEM.

Figs. 7–9. *Exobasidium deqenense* on *Rhododendron* sp. (HKAS 36550, holotype). 7. Symptoms. 8. Basidia, sterigmata and basidiospores as seen by LM. 9. Basidium, sterigmata and basidiospores as seen by SEM.

Figs. 10–13. *Exobasidium canadense* on *Rhododendron* sp. (HMAS 167371). 10. Symptoms. 11. Colonies on PDA. 12. Basidiospores as seen by LM. 13. Basidia, sterigmata and basidiospores as seen by SEM.


4
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Thirty-one species of *Exobasidium* have been reported in China (Sawada 1922, Teng 1963, Tai 1979, Guo et al. 1991, Zang 1996, Li & Guo 2006a,b, 2008a,b, 2009), including the three species recorded in this paper.

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A new species of *Arachnopeziza* from Taiwan

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Abstract — This paper describes and illustrates a new species, *Arachnopeziza hiemalis,* collected from Taiwan. It mainly differs from *A. aurelia* by its small apothecia and large ascospores.

Key words — discomycetes, *Helotiales*, *Hyaloscyphaceae*

Introduction

In Korf's monograph of *Arachnopezizeae, Arachnopeziza* Fuckel was delimited as apothecia seated on subiculum, with hyaline excipulum, straight hairs, and 1–7-septate ascospores. A total of twelve species were recognized in this genus (Korf 1952). Some new species were later added (Korf 1959, Batista et al 1960, Batista & Bezerra 1961, Dennis 1961, 1963, Korf & Zhuang 1985, Svrček 1988, Iturriaga & Korf 1988, Baral 1989, Engel 1993). Recently, Yu & Zhuang (2002) reported *A. colachna* from tropical China and Raitviir (2003) reported *A. groenlandica* with aseptate ascospores from Greenland. While investigating the fungal flora at Juiyenhsi Nature Reserve, Nantou, a species of *Arachnopeziza* was collected, which appears to differ from all known species of the genus. Description and illustration of this species are presented in this paper. Microscopic structures were studied under a light microscope with differential interference contrast lenses, and measurements were made from fresh materials in distilled water mounts. The specimens are deposited at the herbarium of National Museum of Natural Science, Taiwan (TNM).

Taxonomy

Arachnopeziza hiemalis Yei Z. Wang, **sp. nov.** Figs 1, 2

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Arachnopeziza aurelia *similis, sed in apothecis minoribus et ascosporis grandibus differt.*

Holotype: Taiwan, Nantou: Juiyenshi Nature Reserve, elev. 2400 m, on rotten wood of broadleaf tree, Dec. 13, 2006, coll. W. N. Chou, WAN 1141 (TNM F22011).

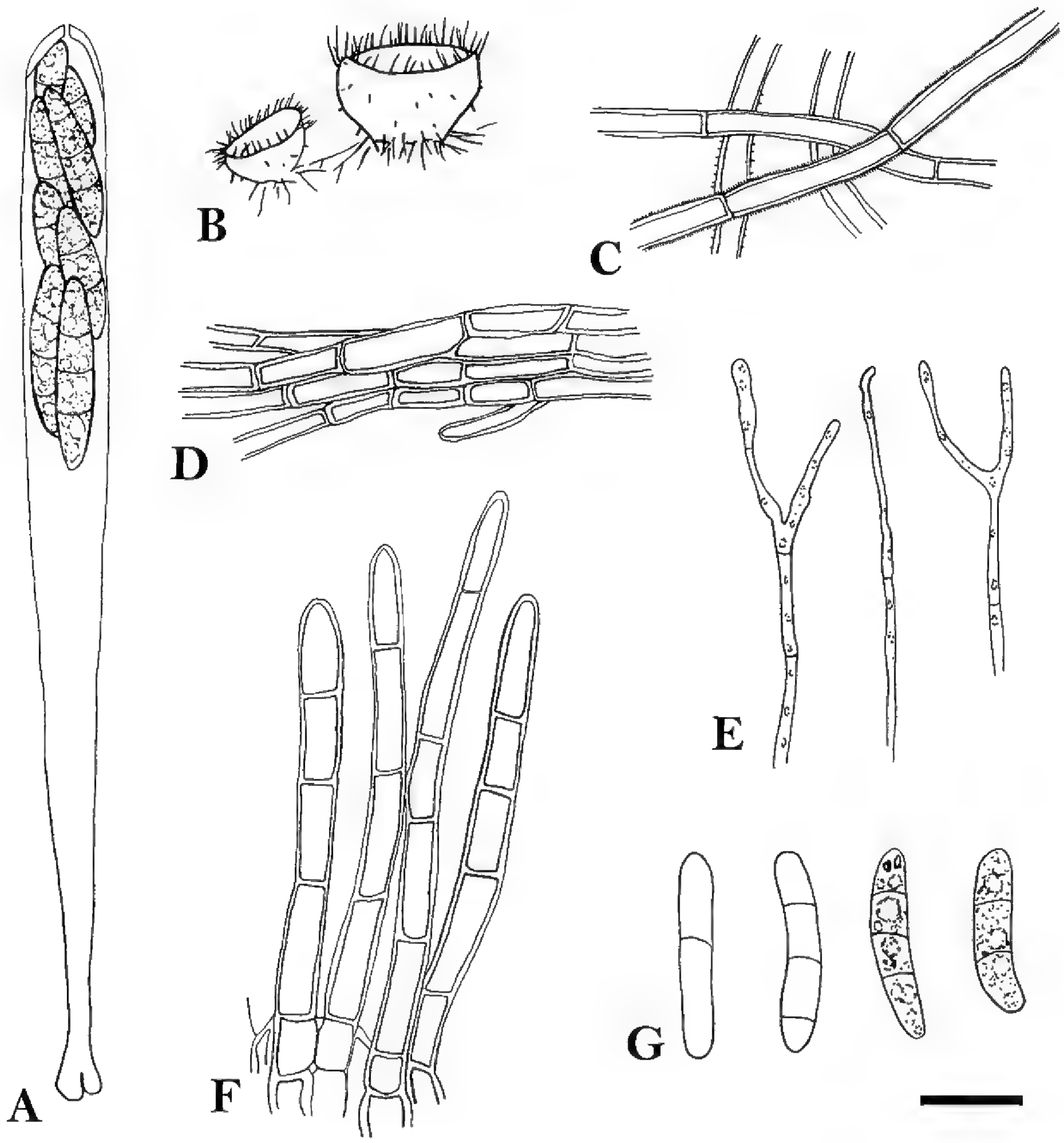

Fig. 1. *Arachnopeziza hiemalis*: A. An ascus. B. Apothecia. C. Hyphae of subiculum. D. A part of ectal-excipulum. E. Paraphysis apices. F. Hairs. G. Ascospores. Bar = 14 µm for A and C–G, 1 mm for B.

Etymology: Latinized form of winter, referring to the season when the specimens were collected.

Subiculum yellowish, scanty; hyphae 3–4 µm wide, smooth or roughened. Apothecia gregarious, globose at first, becoming cupulate to patellate, 0.5–1.5 mm wide, sessile, disc concave to flat, lemon yellow when fresh, turning to dark orange-yellow when dry; receptacle concolorous, surface covered by yellow hairs, bottom entangled with pale yellow mycelium. Margin elevated and usually inrolled on drying. Hairs arising from excipular cells, straight,

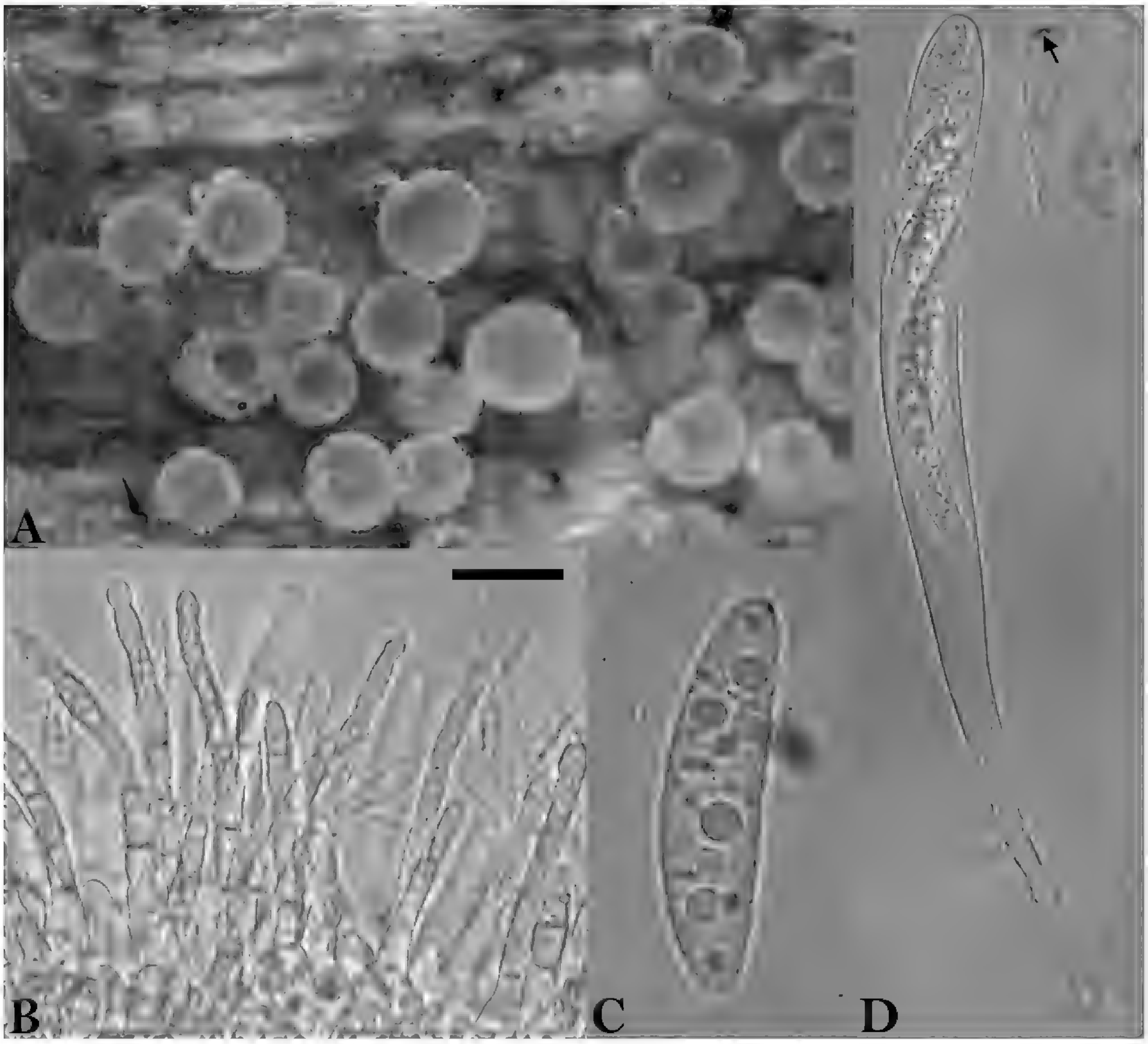

Fig. 2. *Arachnopeziza hiemalis*: A. Apothecia. B. Hairs. C. An ascospore. D. An ascus and an apical pore turning blue in Melzer's reagent (arrow).
Bar = 1.2 mm for A, 25 µm for B, 6 µm for C, and 15 µm for D.

yellow, cylindrical, slightly tapering at apex, smooth to finely granulate, 40–100 × 5–6 µm, mostly 4–5-septate, walls 0.2–0.8 µm in thickness. Ectal excipulum layer 50–100 µm thick, refractive, of *textura prismatica*, cells 10–20 × 3–5 µm, wall 0.5–1 µm in thickness, arranged at a low angle to the surface, cells extending to form marginal hairs. Medullary excipulum layer 50–70 µm thick, compactly arranged hyphae, 3–4 µm wide. Subhymenium not distinguishable. Hymenium yellow, 150–170 µm thick. Asci 8-spored, arising from croziers, cylindrical-clavate, 115–150 × 11–12 µm, apex rounded, apical pore turning blue in Melzer's reagent without KOH pretreatment and in IKI solution with KOH pretreatment. Ascospores ellipsoid, 20–28 × 4.5–5.5 µm, with 1–3 septa at maturity, straight to slightly curved, smooth, hyaline, multiguttulate, devoid of a gel sheath. Paraphyses filiform, tips simple or branched, 1–2 µm wide, septate, not protruding above the asci, filled with yellow-orange pigment granules.

Ascospores easily germinating on water agar. Colonies on MEA medium spreading very slowly. Mycelium brown, aerial hyphae scanty, margin irregular, reaching 1.2–2 cm diam. in 3 months at room temperature, then stopping growing, with brownish-red pigments. Hyphae yellow-brown, septate, 3–5 μm wide, wall 0.2–0.5 μm in thickness. Anamorph not observed.

Paratype specimens examined: Taiwan, Nantou: Juiyenhsi Nature Reserve, elev. 2400 m, on rotten wood, Jan. 22, 2005, coll. W. N. Chou, WAN1039, (TNM F22018). Juiyenshi Nature Reserve, elev. 2400 m, on rotten wood of broadleaf tree, Dec. 13, 2006, coll. W. N. Chou, WAN 1142 (TNM F20758)

This species is similar to *A. aurelia* (Pers.) Fuckel in its yellow-orange apothecia and 3-septate ascospores, but the latter has larger apothecia (0.5–3 mm), and smaller asci and ascospores (12.2–16.4 × 2.7–4.1 μm, Korf 1952; 12–20 × 3–5 μm, Dennis 1981). The hyaline gelatinous appendages or a bud-like protrusion each at the ends of ascospores as described by Korf (1952) and Huhtinen (1987) and illustrated by Boudier (1910) were not observed in this new species.

Arachnopeziza engelii Svrček, *A. obtusipila* Grelet and *A. ochracea* (Grelet & Croz.) Iturr. & Korf also have 3-septate ascospores. But *A. engelii* has cream to pink apothecia, and narrower ascospores (20–24 × 3.5–4.0 μm, Engel, 1993), *A. obtusipila* has white apothecia, shorter asci, and narrower ascospores as 2.7–3.4 μm wide (Korf 1951, 1952), and *A. ochracea* has beige apothecia, shorter asci and smaller ascospores (16.8–21.3 × 2.6–3.7 μm, Iturriaga & Korf 1988).

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Studies in lichen and lichenicolous fungi: more notes on taxa from North America

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Abstract — The following taxa are reported for the first time from North America: *Arthonia diploiciae, Opegrapha dolomitica, Reconditella physconiarum, Sarcogyne sphaerospora,* and *Thalloloma anguiniforme.*

1. ***Arthonia diploiciae*** Calat. & Diederich, Mycotaxon 55: 366. 1995.

Type: Spain, Almeria, Campo de Dalias, Punta del Sabinal, 10 m, on *Diploicia canescens* on *Juniperus phoenicea*, 16.iii.1993, *E. Barreno et al. s.n.* (VAB–lich. 7547, holotype; IMI–362752, isotype).

Arthonia diploiciae is a lichenicolous fungus on the thallus of *Diploicia canescens* (Dicks.) A. Massal., arising in groups of up to 125 ascomata, 70–130 µm each in diameter, and inducing conspicuous brown spots on the thallus of the host. The asci are 4-spored and the ascospores 1-septate, with the lower cell slightly attenuated, apices rounded, 15–22 × 7–12 µm (see illustration and full description in Calatayud et al. 1995). The species was described from Spain and Portugal and has been reported from the Canary Islands and Mexico (Hafellner 1995), Great Britain (Hawksworth 2003) and Ireland (Santesson 1998). *Arthonia diploiciae* is frequent on *D. canescens* on the stems of *Coreopsis gigantea* (Kellogg) H.M. Hall, on East and West Anacapa Islands in the Channel Islands National Park in Ventura County, California. The species is currently included on the North American Checklist (Esslinger 2008) as occurring in North America north of Mexico on the basis of "North America" having been cited in the "World Distribution" section of the entry for this species in the treatment of Sonoran *Arthonia* species by Grube (2008). The species has

previously been known in North America only from Baja California, Mexico and our reports verify it as occurring in North America north of Mexico.

Specimens examined. — **U.S.A. California. Ventura Co.:** East Anacapa Island, Channel Islands National Park, between the lighthouse and NPS housing on slopes above and below trail, 55 m, 34°00'56"N 119°21'43"W, on *Diploicia canescens* on *Coreopsis gigantea*, 30.xi.2008, *K. Knudsen 10753* (UCR); north side, 52 m, 34°00'54"N 119°22'04"W, on *Diploicia canescens* on *Coreopsis gigantea*, 3.xii.2008, *K. Knudsen 10912.2* (UCR); West Anacapa Island, Channel Islands National Park, slope above Rat Rock, 34°00'48"N 119°26'32"W, 28 m, on *Diploicia canescens* on *Coreopsis gigantea*, 19.xi.2008, *J. Kocourková & K. Knudsen* (PRM 915316).

2. ***Opegrapha dolomitica*** (Arnold) Clauzade & Cl. Roux ex Torrente & Egea, Bibl. Lichenol. 32: 146. 1989.

Opegrapha rupestris var. *dolomitica* Arnold, Flora 43: 78. 1860.

Type: [Germany], "An einer Dolomitwand im Laubwalde des Ankathales zwischen Hersbruck und Velden", viii.1859, *F.C.G. Arnold s.n.* [= *? Lich. Exs. 104*] (L, lectotype; NY!, isolectotype?).

Opegrapha gyrocarpa var. *dolomitica* (Arnold) Körb., Parerg. Lich. p. 251. 1865.

"Opegrapha dolomitica" (Arnold) Clauzade & Cl. Roux, Bull Soc. Bot. Centre-Ouest, nouv. sér., num. spec. 7: 827. 1985, nom. inval.

During the recent Tuckerman Workshop (September, 2008) on the Bruce Peninsula of Ontario, Canada, the author and his colleagues had the opportunity to visit calcareous habitats along the shoreline of Georgian Bay of Lake Huron. At one locality we collected several specimens of an *Opegrapha* species growing on calcareous rock ledges and cool humid overhangs. Study of this material revealed that it represented *Opegrapha dolomitica* a rare European species of calcareous rocks (Torrente & Egea 1989). Several collections made by the first author while surveying limestone barrens on the Great Northern Peninsula of the Island of Newfoundland, Canada, also represent *O. dolomitica*. *Opegrapha dolomitica* can be identified by its occurrence on calcareous rocks, esorediate thallus, absence of secondary lichen substances (C–, K–, P–, UV–), 3-septate ascospores ((20–)22–26(–31) × 5–8 µm fide Clauzade & Roux 1985), irregularly shaped ascomata (+/– circular to elongate short lirellae) with epruinose discs, an I+ persistently red hymeniun and K– epihymenium. These are first reports of *O. dolomitica* from North America. Further populations are likely to be found on calcareous shoreline rocks in boreal/sub-arctic regions of North America.

While preparing the discussion for this paper we reviewed the correct authority for the combination using the name *O. rupestris* var. *dolomitica* at the species level. The combination *O. dolomitica* was not validly published by Clauzade & Roux (1985) because they cited the wrong basionym and place of publication ("*O. gyrocarpa* v. *dolomitica* Körb., Parerg. Lich., 251. 1861"). Unfortunately this cannot be treated as a bibliographic error to be corrected because Körber (1865 [not 1861]) included a direct reference to the correct

basionym and place of publication ("Syn. *Opegrapha rupestris* β *dolomitica* Arnold in Flora 1860 p.78"). Thus the place of valid publication is Torrente & Egea (1989) not Clauzade & Roux (1985).

Specimens examined. — CANADA. **Newfoundland & Labrador:** Island of Newfoundland, Watts Point Ecological Preserve, 20.vii.2006, *J.C. Lendemer 8830* (NY), 17.viii.2007, *J.C. Lendemer 17056 & A. Moroz* (NY, distributed as *Opegrapha* sp. *in Lich. East. N. Amer. Exs. VI: 293*). **Ontario. Bruce Co.:** Bruce Peninsula National Park, Halfway Log Dump on Georgian Bay, 19.ix.2008, *J.C. Lendemer 14154–A* (NY), *J.C. Lendemer 14156–A* (NY), *J.C. Lendemer 14174* (NY).

3. ***Reconditella physconiarum*** Matzer & Hafellner, Bibl. Lichenol. 37: 47. 1990.

Type: Austria, Steiermark, Gesäuse-Gebiet, John´s brook, ca. 0.5 km E of tavern Köbl, ca 875 m, MTB 8453/4, on *Fraxinus excelsior*, on *Physconia distorta*, 20.v.1988, *J. Hafellner 20271 & E. Schreiner* (GZU, holotype; hb, Hafellner, hb. Matzer, isotypes).

Reconditella Matzer & Hafellner is a monospecific genus in the *Sordariales* (Matzer & Hafellner 1990). *Reconditella physconiarum* is characterized with brownish-black perithecioid ascomata sitting in the lower part of the lobe edges, without developed basal subiculum, 220–400 µm wide, 200–500 µm high, with periphyses and unbranched or infrequently branched interascal filaments, 8-spored asci functionally unitunicate and ascospores non-septate to occasionally with 1 septum above median level (rarely median), ellipsoid or in the lower part narrower, at first hyaline and halonate, becoming in maturity light brown and slightly verrucose, (13–)15–17.7–21(–24) × (6–)8–10(–13) µm. It is considered a parasymbiont. It is known on *Physconia distorta* (With.) J.R. Laundon, *P. muscigena* (Ach.) Poelt, and *P. venusta* (Ach.) Poelt and it is reported from Austria, Croatia, Portugal and Sweden (Matzer & Hafellner 1990) as well as from Spain (Etayo & Diederich 1998), Russia (Zhurbenko 2004), and Germany (Kocourková & Brackel 2005).

The ascomata in North American specimen of *Reconditella physconiarum* are about 300 µm in diam. and are in the lower range of size compared to ascomata in European specimens on *Physconia*. They differ from European specimens in the ascomata usually penetrating the thallus from the lower side. Only occasionally do ascomata develop at the edges of lobes as in European specimens. Moreover, it seems our specimen is parasitic rather than parasymbiotic: the host thallus is suppressed in size and slightly bleached where the infection is most developed. In some parts, the host thallus is infected with another lichenicolous fungus, *Syzygospora physciacearum* Diederich. Here we report *R. physconiarum* as new to North America from southern California on the new host *Physconia isidiigera* (Zahlbr.) Essl.

Specimen examined. — **U.S.A. California. Riverside Co.:** Santa Ana Mountains, Santa Rosa Plateau, near Tenaja Road, 626 m, 33°29'59"N 117°21'17"W, on *Physconia isidiigera*, on *Quercus agrifolia*, 11.iv.2007, *J. Kocourková & K. Knudsen* (PRM 915343).

4. ***Sarcogyne sphaerospora*** J. Steiner, Österr. Bot. Zeitschr. 49: 251. 1899.

TYPE: Armenia, Caucasus Mountains (holotype not located).

During recent collecting trips in the mountains of southern California above 5000 feet, we discovered a lichenicolous taxon of the *Acarosporaceae* with a carbonized exciple and epihymenium, having spherical ascospores 4–5 µm in diameter with a distinct perispore or mucilage layer, parasitic on *Candelariella rosulans* (Müll. Arg.) Zahlbr. The taxon was not conspecific with any species of lichenicolous *Polysporina* Vězda that we recently studied (Knudsen & Kocourková 2008). Instead it appears to be *Sarcogyne sphaerospora*, described as a parasite on *Candelariella vitellina* (Ehrh.) Müll. Arg. from the Caucasus Mountains of Armenia. The holotype was supposed to be deposited at W but was not located (pers. comm., O. Breuss). Until we can locate the type and further specimens we include our specimen in the concept of *S. sphaerospora* and report it new to North America (Esslinger 2008). Though the species definitely fits in the current concept of the genus *Polysporina* (Vězda 1978) we refrain from transferring the species from *Sarcogyne* Flot. until we have completed a revision. We hope this report may bring to our attention more specimens for study. We do not expect *S. sphaerospora* at this time to be restricted to members of the genus *Candelariella* Müll. Arg. because none of the other lichenicolous species of *Polysporina* we have recently treated is host specific.

We doubt the validity of *Polysporina* as a natural genus. Our study of the genus has found that the only character distinguishing the genus from the core group of *Sarcogyne* is a carbonized epihymenium (Knudsen 2008a; Knudsen & Kocourková 2008). We agree with Claude Roux (pers. comm.) that a carbonized epihymenium does not appear to be a robust systematic character to distinguish a genus, though it is useful as a taxonomic character for distinguishing species in *Acarosporaceae*. Recent unpublished molecular results from sequencing *Polysporina* specimens by Valerie Reeb (pers. comm.) and Martin Westberg (pers. comm.), although not conclusive, suggest that a carbonized exciple and epihymenium and a lichenicolous habit may have arisen several times in the phylogeny of the *Acarosporaceae*. If this is true, we speculate if *Sarcogyne sphaerospora*, is related to two *Acarospora* species that have spherical ascospores with a distinct perispore or mucilage layer, and that are lichenicolous parasites when juvenile, but which develop independent lichenized thalli with non-carbonized aspicilioid apothecia when mature: *A. stapfiana* (Müll. Arg.) Hue and *A. succedens* H. Magn. (Knudsen 2008b).

SPECIMEN EXAMINED. — **U.S.A. CALIFORNIA. San Bernardino Co.:** San Bernardino Mountains, San Bernardino National Forest, FS 2N93 off CA 38, Moonridge Quad., 7462 ft., 34°10'29"N 116°47'11"W, conifer/oak woodland with granite outcrops, on *Candelariella rosulans* on granite, 7.x.2008, *J.C. Lendemer 14917–A & K. Knudsen* (NY).

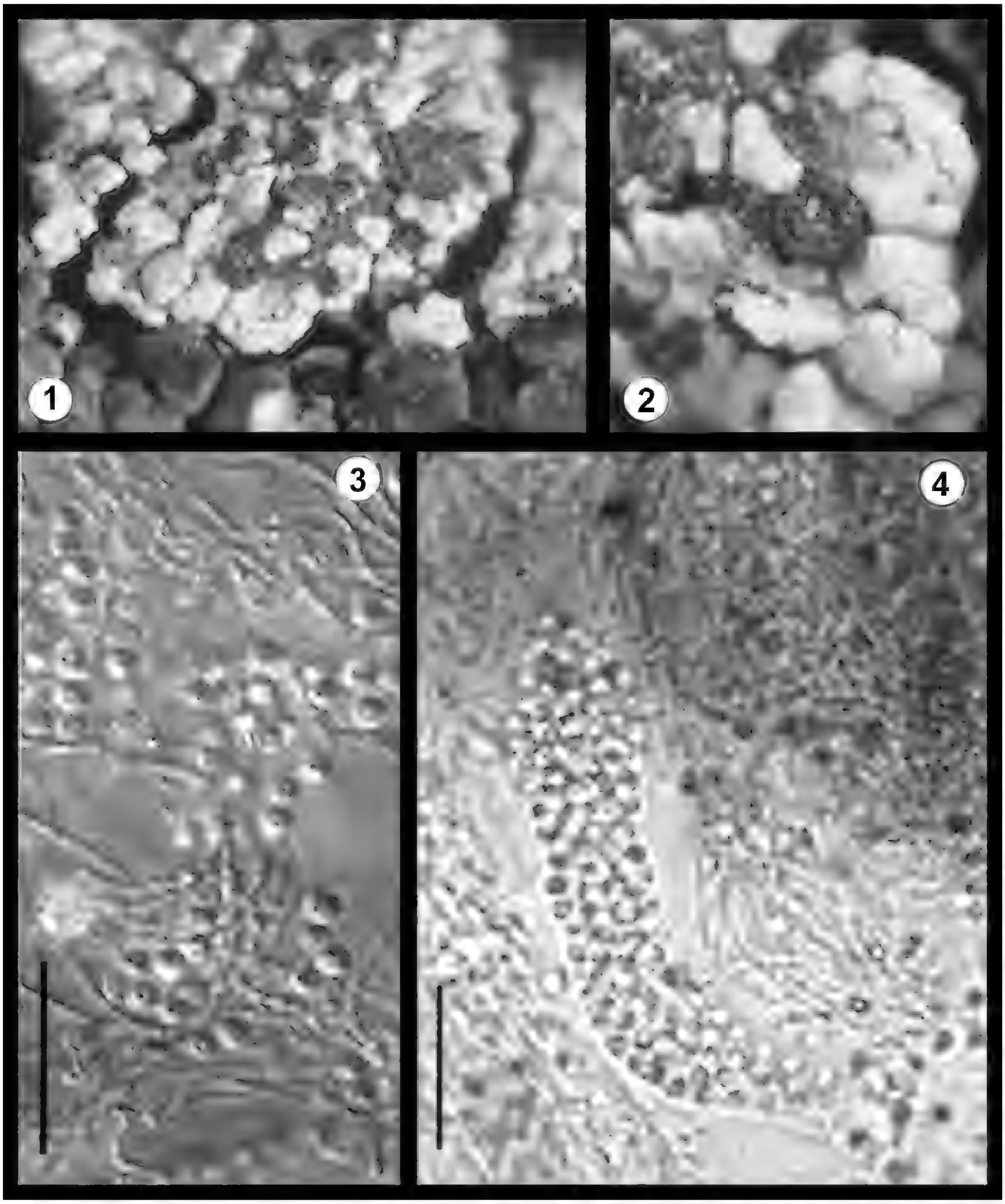

PLATE 1. ***Sarcogyne sphaerospora*** (Lendemer 14917-A, NY). FIGURE 1, gross morphology of infection (x 10). FIGURE 2, detail of apothecium (x 20). FIGURE 3, ascospores and paraphyses (scale bar = 20μm). FIGURE 4, intact ascus with ascospores (scale bar = 20μm).

5. ***Thalloloma anguiniforme*** (Vain.) Staiger, Bibl. Lichenol. 85: 427. 2002, as "*anguinaeforme*".

Graphis anguiniformis Vain., Acta Soc. Fauna Fl. Fenn. 7(2): 110. 1890, as "*anguinaeformis*".
TYPE: Brazil, Minas Gerais, ad corticem arboris in Carassa, 1400 m., 1885, *E.A. Vainio s.n.* = *Lich. Bras. Exs. 274* (TUR, holotype; M, isotype).

Graphina anguiniformis (Vain.) Zahlbr., Cat. Lich. Univ. 2: 398. 1923, as "*anguinaeformis*".

Recently we began the task of updating the North American species of *Graphidaceae* (in the traditional sense not including the *Thelotremataceae*) to follow the modern generic concepts proposed by Staiger (2002). In conjunction with this reorganization we have also attempted to resolve the status of the taxa that have been recognized but not formally named (e.g., Harris 1990, 1995) as well as identify undetermined material that has accumulated at various herbaria. This work has yielded the discovery of another subtropical species in Florida that has not previously been reported from North America, *Thalloloma anguiniforme*.

Species of *Thalloloma* Trevis. can be recognized by a lack of carbonization in the exciple, hyaline ascospores, non-warty paraphysis tips that are brown and granular, the absence of periphysoids, and non-fissurine apothecia with exposed discs. Among species of *Thalloloma,* the species reported here can be recognized by its unpigmented discs and large muriform ascospores (55–95 × 25–30 µm fide Staiger (2002)). The chemistry of *T. anguiniforme* was not given by Staiger (2002) because of the only specimen available at that time was too small for analysis. The specimen reported here contains lichexanthone (K–, C–, KC–, P–, UV+ yellow).

Specimen examined. — **U.S.A. Florida. Dixie Co.:** Steinhatchee Wildlife Management Area, along Andrew Sauls Rd., ca. 0.4 mi N of Co. Rd. 351 just N of Scrub Creek Baptist Church, ca. 6 mi NE of Cross City, oak scrub and oak woods, on *Quercus*, 4.xii.1993, *R.C. Harris 31618–A* (NY).

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Two new xylariaceous species from Kenya

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Abstract — A survey of wood rotting ascomycetes in Kenya produced taxa in *Biscogniauxia* and *Kretzschmaria* that did not match descriptions of any known species and are hereby described as new species. The species of *Biscogniauxia* differs from known species by having small globose ascospores and a non-amyloid apical ring, while that of *Kretzschmaria* differs by having small non-stipitate stroma.

Key words —*Ascomycota*, *Xylariaceae*, taxonomy

Introduction

During a field study on wood degrading ascomycetes in Kenya, we encountered two interesting ascomycete fungi fitting characteristics of *Biscogniauxia* Kuntze and *Kretzschmaria* Fr. After careful examination, the collections did not match characteristics of any species described in the genera and are hereby described as new species.

The genus *Kretzschmaria* was recently revised by Rogers & Ju (1998) to also include some taxa previously placed under *Ustulina* Tul. & C. Tul. The stromata of *Kretzschmaria* are superficial ranging in shape from peltate, discoid, restricted pulvinate, to effused pulvinate. They are attached to the substrate by definite stipes or by narrow connectives and can either be gregarious, discrete, or fused into a crust. Mature stromata have a carbonaceous outer layer encasing a rather soft white to blackish inner layer. The stromata also lack KOH extractable

pigments. The asci are cylindrical and short stipitate with an amyloid apical ring. The ascospores are brown to dark brown and ellipsoid to fusoid with a straight or sigmoid germ slit on the convex side that is either spore length or less and exhibits perispore indehiscence in 10% KOH. *Biscogniauxia*, which was also recently revised by Ju et al. (1998), includes species that have erumpent, solitary, or confluent stromata, and are applanate, effused-pulvinate or raised discoid in shape. Mature stromata lack KOH extractable pigments. The asci are 8-spored, cylindrical, short stipitate, and persistent with an apical ring that is amyloid or rarely inamyloid. The ascospores are brown, unicellular, lack dehiscent perispores, and often have a cellular appendage. Their shapes range from ellipsoid to short fusoid, inequilateral to equilateral with narrowly to broadly rounded ends. The germ slits are spore length or less than spore length, straight or sigmoid, and the epispore is smooth or occasionally ornamented. Our collections fit the characteristics of their respective genera. For other taxa treated in the genera, see Rogers et al. (http://mycology.sinica.edu.tw/xylariaceae).

Taxonomy

Kretzschmaria parvistroma Mugambi, Huhndorf & J.D. Rogers, **sp. nov.** FIGS. 1–7
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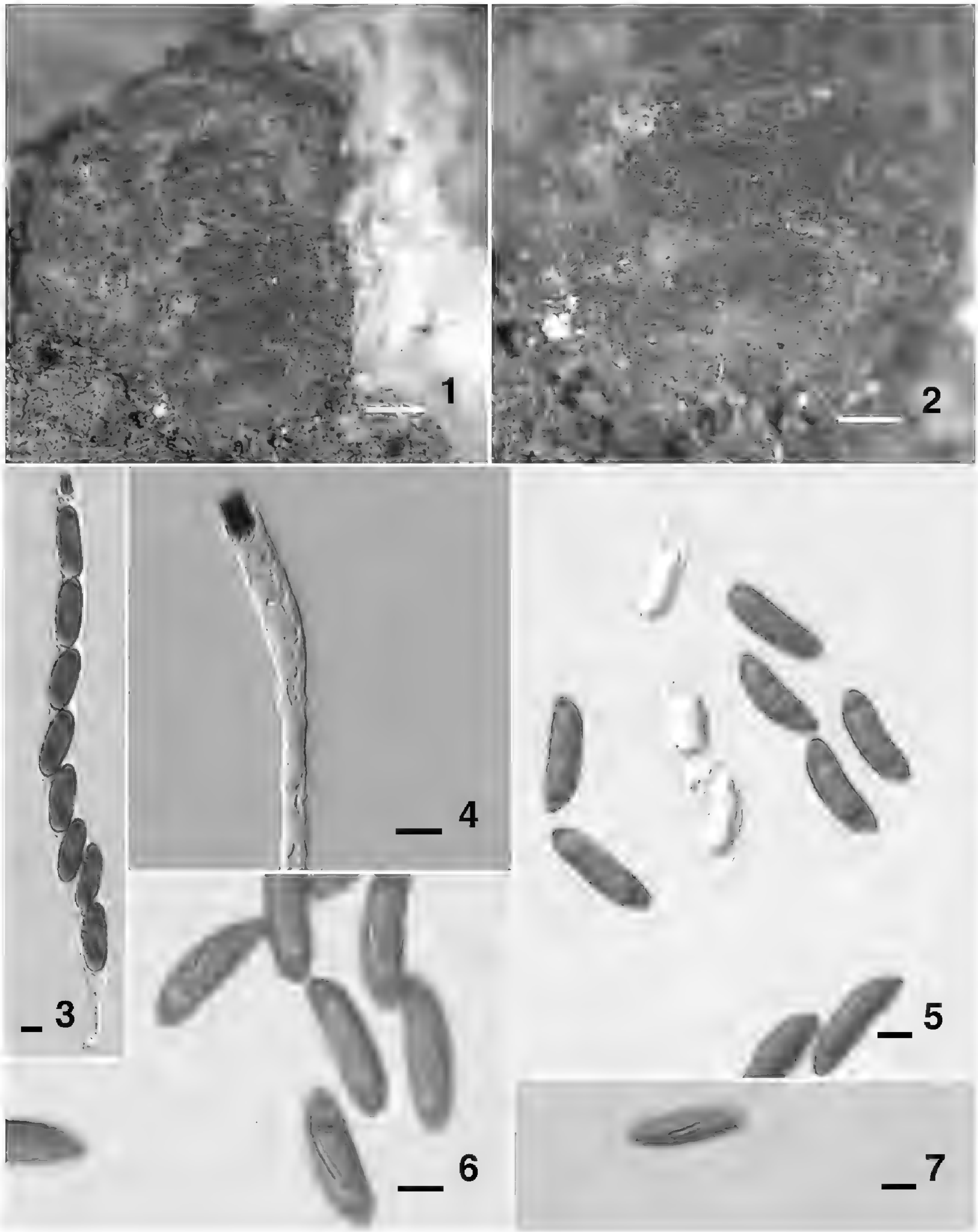
Stromata pulvinata, usque ad 7 mm longa × 4 mm lata × ca. 1 mm alta, late in substrato affixa, superficie fusca, intus nigra. Textura carbonacea. Perithecia globosa, usque ad 0.8 mm diam. Ostiola subtiliter papillata. Asci deliquescentes, annulo apicali in liquore iodata Melzeri cyanescente, urceolatis, ca. 9 µm alto, 5 µm crasso, plerumque colore in ascum extensum. Ascosporae brunneae, unicellulares, leves, sub ellipsoideae vel sub cylindrici vel plus minusve allantoidei, (34–)37–38(–39) × (10–)12–13 µm, rima germinativa brevissima, recta vel oblique praeditae. Paraphyses abundans. Anamorphosis ignotus.

HOLOTYPE: Kenya, Coast Province, Taita-Taveta District, Taita Hills, Ngangao forest reserve, S 3^0 22.301', E 38^0 20.446', 1800 m elev., Apr 2005, on woody branch 1 cm diameter, G.K. Mugambi 188N (**Holotype** EA).

ETYMOLOGY: Refers to the size of the stroma, bearing small stroma

Stromata pulvinate, up to 7 mm long × 4 mm diam × ca. 1 mm high, with broad attachment to substrate, surface dark brown, interior blackish, carbonaceous. Perithecia globose, up to 0.8 mm diam., ostioles finely papillate. Paraphyses abundant, extending beyond asci, cylindric, branched, septate, 2–4 µm wide. Asci fragmentary, cylindric, short stipitate, 218–295 × 11–15 µm, with urn-shaped, amyloid apical ring, ca. 9 µm high, 5 µm broad, with bluing usually extending into ascus below ring. Ascospores brown, smooth, unicellular, subellipsoid, subcylindrical or more or less allantoid, (34–)37–38(–39) × (10–)12–13 µm, with germination slit short, mainly occupying central part of spore, 8–10 µm long, straight to oblique. Anamorph unknown.



Figs. 1–7. *Kretzschmaria parvistroma*. 1–2. Stroma on substratum. 3–4. Asci. 5–7. Ascospores. Bars: 1–2 = 1 mm; 3–7 = 10 µm.

Habitat and distribution: On decorticated wood and known only from Kenya.

Comments: *Kretzschmaria parvistroma* differs from the species currently accepted in the genus by its unusually small stromata for a non stipitate *Kretzschmaria*. The ascospore shape and ascus ring shape resemble those

of *K. cetrarioides* (Welw. & Curr.) Sacc. that has been reported from several parts of Africa (see Rogers & Ju 1998). However, our species differs by having sessile stromata as opposed to the stipitate ones reported for *K. cetrarioides*. *Kretzschmaria lucidula* (Mont.) Dennis possesses ascospores that slightly overlap in size with *K. parvistroma* but differs by having stromata that are attached to the substrate by narrow connectives and with fine vertical striations on the sides. *Kretzschmaria pavimentosa* (Ces.) P.M.D. Martin, first described from Asia but later reported widely in tropical and temperate regions, shares some similarities in asci and ascospore morphology with our species. However, it differs markedly by stromata usually densely aggregated and attached to the substrate by narrow connectives thus appearing as though stipitate (see Rogers & Ju 1998). Unfortunately, we were unable to obtain cultures from our collection.

Biscogniauxia kenyana Mugambi, Huhndorf & J.D. Rogers, **sp. nov.** FIGS. 8–14
MYCOBANK MB511845

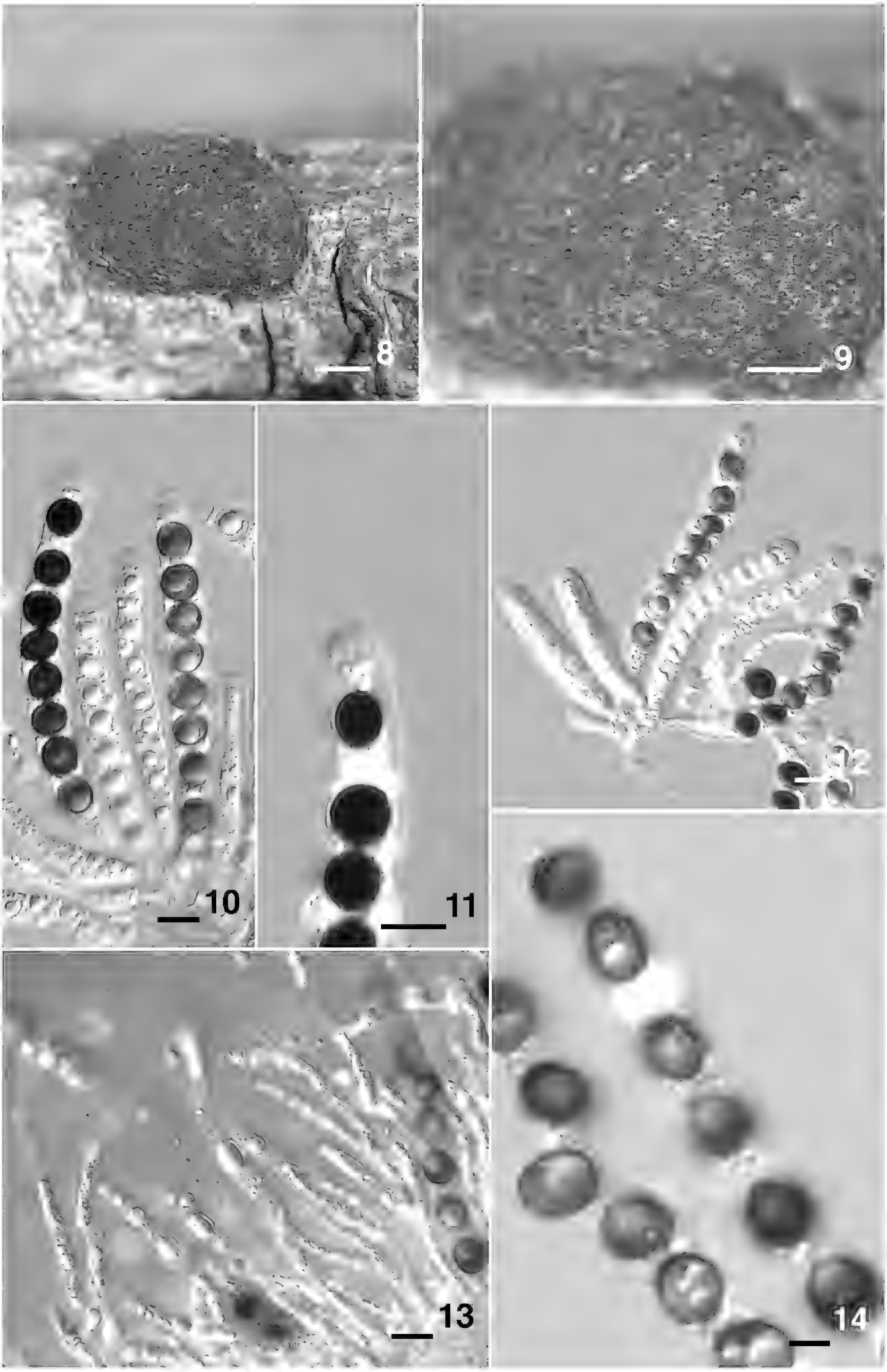
Stromata pulvinata, 2–4 mm longa × 2–3 mm lata × 1–1.5 mm crassa, superficies matura sub fusca; textura sub superficie et inter perithecia plus minusve carbonacea; textura sub peritheciis inconspicua. Perithecia plus minusve globosa, ca. 0.5 mm diam. Ostiola subtiliter papillata inconspicua. Asci cum 1 usque ad 8 ascosporis praediti, brevistipitati, ca. 110 μm longitudine tota × ca. 10 μm crassi, annulo apicali in liquore iodata Melzeri non cyanescente. Ascosporae fuscae, unicellulares, leves, sub globosa, 10–12 × 7–9(–9.5) μm aut globosa, 8 μm usque ad 10 μm, rima germinativa recta interdum pro parte majore cingenti praeditae. Paraphyses inclusae. Anamorphosis ignotus.

HOLOTYPE: Kenya, Coast Province, Malindi District, Arabuko-Sokoke National Park, S 3⁰ 19.277', E 39⁰ 55.422', 42 m elev., May 2005, on woody branch 3 cm diameter, G.K. Mugambi 247A (**Holotype** EA).

ETYMOLOGY: Refers to the type locality.

Stromata pulvinate, 2–4 mm long × 2–3 mm broad × 1–1.5 mm high, with brown surface, tissue beneath surface and between perithecia more or less carbonaceous, tissue beneath perithecia highly reduced. Perithecia more or less globose, ca. 0.5 mm diam. Ostioles finely papillate slightly raised from stromatal surface, appearing slightly darker than the stromatal surface. Paraphyses abundant, extending beyond asci, cylindric, tappering towards the tip, branched, regularly septate, 3–4 μm broad. Asci short-stipitate, 97–112 × 9–12 μm, with apical ring inamyloid, with 1 to 8 ascospores. Ascospores brown to dark brown, hyaline when young, unicellular, smooth, subglobose, 10–12 × 7–9(–9.5) μm, to globose, 8–10 μm diam., with germination slit straight, sometimes surrounding major part of spore. Anamorph unknown.

FIGS. 8–14. *Biscogniauxia kenyana*. 8–9. Stroma on substratum. 10–12. Asci. 13. Paraphyses. 14. Ascospores. Bars: 8 = 1 mm; 9 = 1 mm; 10–14 = 10 μm.


8
9
10
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14

Habitat and distribution: On decorticated wood and known only from Kenya.

Comments: *Biscogniauxia kenyana* resembles *B. schweinitzii* Y.M. Ju & J.D. Rogers (Ju & Rogers 1998), the only other known *Biscogniauxia* species with subglobose ascospores. This species differs from *B. kenyana* in having ascospores that are distinctly flattened or laterally compressed. In *B. schweinitzii* the stromatal surface is less curved and more distinctly flat than in *B. kenyana* and the ostioles are lower than the stromatal surface. An amyloid ascus ring is present in *B. schweinitzii* and absent in *B. kenyana*. Another species described from Africa, *B. africana* Y.M. Ju & J.D. Rogers, differs from *B. kenyana* in having stromata that are raised discoid with a plane surface and conspicuously raised margins and in having ascospores that are equilateral ellipsoid, not subglobose. An apparent diagnostic characteristic of *B. kenyana* is the variable numbers of mature ascospores in the asci. Most asci appear initially to have eight ascospores, but in many cases, fewer than eight attain the brown color of maturity and appear to disintegrate.

Acknowledgments

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Proposals 048–051 to amend the International Code of Botanical Nomenclature

[Published concurrently in Taxon]

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(048–051) Proposals to exclude the phylum *Microsporidia* from the Code.

(048) Add to Preamble paragraph 7 after "slime moulds" the following phrase:
", but excluding the phylum *Microsporidia*;"

(049) Add to the end of Art. 13.1(d) the following sentence:
"Microsporidian names are governed by the International Code of Zoological Nomenclature (see Preamble 7)."

(050) Remove Art. 45 Ex. 10.

(051) Add to Art. 54.1(a) after the word "plants":
", including all *Microsporidia*,".

The phylum *Microsporidia* comprises more than 150 genera and 1,200 species of obligate intracellular parasites of eukaryotes (Keeling & Fast in Ann. Rev. Microbiol. 56: 93– 116. 2002). All microsporidia produce infective spores that

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contain a characteristic distinctively coiled polar filament. Microsporidians are easily recognized and distinguished from all other groups of microscopic eukaryotes. They are also unusual at the physiological level in that they have relic mitochondria termed mitosomes.

The phylum *Microsporidia* has been either ignored in eukaryote systematics or treated as a group of protozoa (e.g., Levine & al. in J. Protozool. 27: 37–58. 1980; Cavalier-Smith in Microbiol. Rev. 57: 953–994. 1993; Wittner & Weiss, The Microsporidia and Microsporidiosis. 1999), with interesting exceptions (Starobogatov in USSR Acad. Sci., Proc. Zool. Inst. 144: 19. 1986). The lack of traditional mitochondria, and accompanying mitochondrial DNA, also led to the notion that they were particularly ancient eukaryotes (Cavalier-Smith in Schenk & Schwemmler, Endocytobiology II: Intracellular Space as Oligogenetic: 1027–1034. 1983). Their exceedingly reduced genomes and highly divergent genes (Keeling & al. in Folia Parasitol. 52: 8–14. 2005) further delayed molecular phylogenetic placement of the group.

A consensus has emerged from molecular phylogenies that the *Microsporidia* are related to fungi (Keeling in Molec. Biol. Evol. 13: 1297–1305. 1996; Edlind in Molec. Phylog. Evol. 5: 359–367. 1996; Hirt & al. in Proc. Natl. Acad. Sci U.S.A. 96: 580–585. 1999; Gill & Fast in Gene 375: 103– 109. 2006). Consequently some taxonomic and evolutionary schemes treat the *Microsporidia* as fungi (Keeling & al. in Trends Ecol. Evol. 20: 670–676. 1995; Cavalier-Smith in Biol. Rev. 73: 247. 1998; Doweld, Prosyll. Tracheophyt. 77. 2001; Adl & al. in J. Eukaryot. Microbiol. 52: 399–451. 2005; Kirk & al., Dict. Fungi, ed. 10. 2008), a realization that if fully carried into the realm of nomenclature would bring with it unwanted consequences. Descriptions of virtually all the species and genera lack Latin diagnoses and/or descriptions. Prior to changes to Art. 45.4 in the International Code of Botanical Nomenclature in Vienna in 2005 (McNeill & al. in Regnum Veg. 146. 2006), names for most microsporidians described after 1935 would not have been validly published under the ICBN. However, such a strong tradition exists in treating *Microsporidia* as protozoans, that even today in research articles where *Microsporidia* are acknowledged to be fungi, new taxa are being named and described without Latin diagnoses or descriptions as required since 1935 by the ICBN for taxa governed by that Code which includes fungi.

The simplest solution for names for taxa in the phylum is to return to the pre-2005 situation by excluding the *Microsporidia* from the ICBN (Redhead, Cushion & Frenkel in J. Eukaryot. Microbiol. 53: 8. 2006). The International Commission on Zoological Nomenclature via the Executive Secretary (Dr. Ellinor Michel, pers. comm., June 2008) confirmed that the ICZN (Ride & al., Intern. Code Zool. Nomencl. 1999 & http://www.iczn.org/iczn/index.jsp)

could continue to cover the names for microsporidians under its Art. 1.1.1. Researchers working on *Microsporidia* have requested that these taxa continue to be treated nomenclaturally as protistans under the ICZN (Weiss in Folia Parasitol. 52: 1–7. 2005). Excluding an easily characterized group traditionally treated as protistan and not fungal (ICBN Preamble 7) is the logical and pragmatic approach. Few complications arise from exclusion of the *Microsporidia*. Despite being excluded from the ICBN as a group, there will continue to be impact from ICBN Art. 54.1(a) regarding homonyms covered by the ICBN.

Nomenclatural novelties proposed in Mycotaxon 108

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Berkleasmium daphniphylli K. Zhang & X.G. Zhang, p. 5
Biscogniauxia kenyana Mugambi, Huhndorf & J.D. Rogers, p. 502
Calvatia oblongispora V.L. Suárez, J.E. Wright & Calonge, p. 324
Cetrelia sayanensis Otnyukova, Stepanov & Elix, p. 250
Crinipellis nigricaulis var. *macrospora* Antonín, R. Ryoo & H.D. Shin, p. 431
Crinipellis rhizomaticola Antonín, R. Ryoo & H.D. Shin, p. 433
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Leucoagaricus viridiflavus (Petch) T.K.A. Kumar & Manim., p. 399

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Reviewers, Volume one hundred eight

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

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Errata

Volume 92

g. 336, line 14:	for: *cerealis,*	read: *cereale,*

Volume 94

p. 99, line 42	for: *T. umkowaani*	read: *T. umkowaan*

Volume 95

p. 291, line 34	for: *T. umkowaanii*	read: *T. umkowaan*

Volume 96

p. 144 line 23, col. 2	for: *Lepidella carpatica*	read: *Lepidella carpathica*

Volume 99

p. 306, line 17	for: *G. argentea*	read: *G. argentius*

Volume 100

p. 237, line 14	for: *Urceoloria*	read: *Urceolaria*

Volume 101

p. 275, line 22	for: *Mertahizium*	read: *Metarhizium*
p. 317, line 12	for: *B. kowhai*	read: *B. kowhaii*
p. 317, line 14	for: *B. lucifera*	read: *B. lucifer*
p. 321, line 6	for: *C. rosea* f. *catenulate*	read: *C. rosea* f. *catenulata*
p. 321, line 33	for: *C. chlorine*	read: *C. chlorina*
p. 329, 5th sp.	for: *C. prunifomentosae*	read: *C. prunitomentosae*

Volume 107

Front cover, 2nd from bottom	*for:* MYXNAE 10X:	*read:* MYXNAE 107:
p. 23, Ackn.line 3	*for:* presubission	*read:* pre-submission

p.148 (bottom 3 lines) + p. 150 (top 2 lines):

for: *Xylaria liquidambaris* J.D. Rogers et al. and *X. jaliscoensis* F. San Martín et al. are also described from *Magnolia* fruits (Rogers et al. 2002). Other fruit-inhabiting species are *X. persicaria* (S519chwein.) Berk. & M.A. Curtis (from *Liquidambar* L. fruits), *X. carpophila* ... (from leguminous fruits) (Rogers 1979b).

read: *Xylaria jaliscoensis* F. San Martín et al. is also described from *Magnolia* fruits (Rogers et al. 2002). Other fruit-inhabiting species are *X. liquidambaris* J.D. Rogers et al. (= X. *persicaria* sensu Rogers 1979b, from *Liquidambar* L. fruits), *X. carpophila* ... (from leguminous fruits) (Rogers 1979b, Rogers et al. 2002).

p. 512,line 25	*for:*...the older *C. indica.*"	*read:*...the older *C. indica.*
p. 512, last line	for: *NY 4853, U.S.A.*	read: *NY 14853, U.S.A.*
p. 536, line 12	for: **Hillis**	read: **Hills**
p. 538, line 5	*for:* 20007].	*read:* 2007].

FROM THE *EDITOR-IN-CHIEF*

NEW INDEX EDITORS — Indexing four MYCOTAXON volumes per year is no easy task and too much to expect from one individual. Therefore this year we decided to distribute the work among four separate indexers. Joining KAREN GETTELMAN, who has so ably served as sole Index Editor for the past thirteen years, are newly appointed HENNING KNUDSEN and returning Editors SUSAN GRUFF and ROBERT DIRIG. We are pleased to extend an appreciative and warm welcome to our newly expanded crew — effectively at work, if we are to judge from the number of 'discovered' errata on the facing page.

FORMAL NOMENCLATURAL PROPOSALS NOW IN MYCOTAXON — Every six years, the International Association for Plant Taxonomy (IAPT) convenes at an International Botanical Congress to discuss and vote on various nomenclatural proposals that have been published in TAXON. Proposals to change the INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE are voted on by all IAPT members. Proposals to conserve or reject names are sent to special permanent committees (in our case, the Nomenclature Committee for Fungi), which evaluate the measures before recommending actions to the General Committee, which in turn forwards its final recommendation to the Congress.

Beginning with the current April–June 2009 volume, MYCOTAXON now will publish, concurrently with TAXON, all fungally oriented proposals. The first two proposals form "book-ends" for Mycotaxon 108 — on pp. 1–4 Props. 016–020 seek to make clear that the CODE covers fungal nomenclature (including updating its name to the INTERNATIONAL CODE OF BOTANICAL AND MYCOLOGICAL NOMENCLATURE) while on pp. 505–507 Props. 048-051 seek to exclude the phylum *Microsporidia* from the CODE.

In future MYCOTAXON volumes, all proposals will stand together in an end section.

COLOR PDFS NOW AVAILABLE FOR EXTRA FEE — The beautiful color in the printed MYCOTAXON (refer to p. 459) is expensive. Authors who have good color photos but cannot afford to pay the press color page fee now may obtain a separate PDF with color images prepared for author use. The charge for processing a color PDF for Internet use is $40. Contact the EDITOR-IN-CHIEF for additional information.

MYCOTAXON 108 — After the summary papers are published in June, we will upload five annotated species lists to join the 45 PDFS already posted on the MYCOTAXON web site, WWW.MYCOTAXON.COM. The 61 papers and 62 new taxonomic names that cover these 522 pages are the result of intensive research by 170 authors and co-authors and assistance from 91 expert peers. The following demonstartes that mycological cooperation is truly international in scope. Three days ago in Oregon, I sent an urgent Email to Spain asking for an important bit of information before converting a manuscript to PDF format. In less than a half hour, a co-author in Pakistan supplied the missing data. The speed of the internet makes it almost easy to serve as both scientist and editor. Almost.

Warm regards,

Lorelei L. Norvell,
MYCOTAXON *Editor-in-Chief*
24 May 2009

Four easy steps to successful Mycotaxon publication

Mycotaxon's complete instructions, which were last updated in November, 2007, are posted on the Instructions to Authors page on the Mycotaxon website listed below. Prospective authors should download instructions PDF, expert reviewer comment and submission forms, and helpful templates by clicking the 'file download page' link on the instructions page before preparing a paper intending for the journal. Below is a summary of our simple '4-step' publication process.

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